UNIVERSITY OF BRISTOL.

THE ANNUAL REPORT

OF THE

Agricultural and Horticultural Research Station

(THE NATIONAL FRUIT AND CIDER INSTITUTE)

LONG ASHTON, BRISTOL,

1927.

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INTRODUCTION.

Following the practice of previous years, this Report deals primarily with the work of the Long Ashton Research Station (The National Fruit and Cider Institute). For reasons given in the last Annual Report reference is made also in this introductory section of the Report to the activities of the Berkeley Square Agricultural Advisory Centre and the Campden Research Station which together with the Long Ashton Station constitute the Agricultural and Horticultural Department of the University of Bristol. The advisory section of this Report deals with work under that head carried out from both Long Ashton and Berkeley Square.

The table of contents of this Report indicates the contributions of the respective members of the research and advisory members of the staff of the Department. The important contribution to the successful working of the Department made by the members of the administrative, assistant and labour staffs cannot be recorded in that way. Hence the opportunity is taken here of acknowledging collectively the valuable and willing help which has been given by all grades in their respective capacities.

Long Ashton Research Station.

In contrast to the two preceding years staff changes during 1927 have been relatively numerous and have resulted in at least temporary interruption in important lines of investigation with which the Station is particularly identified. As far as possible a break in continuity has been avoided by remaining members of staff adding to their already full programmes the recording incidental to the experiments in progress. It has been difficult under the circumstances to give adequate attention to certain subjects in which it had been hoped that considerable headway might have been made during the year. In addition the course of development of the pathological investigations on the strawberry rendered it necessary for Mr. Staniland, the Entomological Adviser of the Station, to devote the major part of his time to that work, Mr. Lees, the Research Entomologist, relieving him of some of the Advisory work. Other events out of the ordinary course, such as the putting into operation of a new scheme of work for the Empire Marketing Board, the Imperial Agricultural Research Conference,

the erection of the new laboratory extension, and a succession of overseas visitors, tended to interfere still further with regular work. Altogether the year has been the most difficult as regards maintenance of normal work since the War.

In spite of these difficulties progress generally has been substantial and important and significant results have been obtained in several lines of work. Equally satisfactory has been the obvious steady development of interest taken in the work of the Station, which has become very marked during the past few years and has been particularly noteworthy during 1927. It has shown itself through correspondence, requests for lectures dealing with the various subjects under investigation, visits to the Station by organised parties as well as by individuals, and in other ways. There has been a notable increase in the number of overseas workers in horticultural science, a result largely attributable to the visit of the Deputy Director to America in 1926 and indicative of the manner in which knowledge of the work of the Station is extending.

The outstanding feature of the year in respect of development of the work is a very considerable extension of the section concerned with the nutrition of fruit trees. This has been made possible by a special maintenance grant from the Empire Marketing Board for a five-year period in addition to a substantial grant for the requisite capital expenditure. The particular problem or, more accurately, series of problems to be investigated is the influence of the conditions under which the fruit tree is grown upon the quality of the fruit. Among the conditions to be taken into account are those of soil, climatic factors, supply of nutrients, and root stock and, among the fruit characters, size, texture, colour, chemical composition, flavour and, in particular, keeping quality. Under this scheme it will be possible to concentrate more intensively than previously on several related lines of work upon which the Station has now been engaged for several years. While the results should be of special advantage to the English fruit grower, since they will be obtained mainly under his own growing conditions, there is little doubt that in many directions generalisations will be possible which should assist growers of fruit in all parts of the Empire in their own local problems, especially in the very important directions of storage and transport.

Staff. The Station has sustained the loss of the services of one of its senior members of staff by the resignation of Mr. A. H. Lees, M.A., whose appointment dates back as far as 1912. He is succeeded as Research Entomologist by Dr. C. H. Walton, who has served as Advisory Entomologist for the North Wales Province.

Mr. C. E. T. Mann, M.Sc., who has held the appointment of Plant Physiologist since 1924, accepted the post of Plant Physiologist at the recently established Rubber Research Station at Kuala Lumpur early in the year. His successor, Dr. T. Swarbrick, commenced his duties in August on his return from the United States, where he had been engaged on post-graduate research at Wisconsin University since December 1926. Dr. Swarbrick has already had recent experience of the work at Long Ashton, having spent two years at the Station as a research scholar of the Ministry of Agriculture immediately prior to his visit to America.

In view of the dearth of suitably trained pomologists, the departure of Mr. E. Ball, M.A., the Research Pomologist, last March to enter a commercial career created a situation of some difficulty in the pomological department. It was decided in consequence to reorganise the staff arrangements of that department. Mr. J. G. Maynard, the Practical Pomologist, has been given charge of the investigations hitherto conducted by Mr. Ball, in addition to his previous duties on the cultural side of the plantation work. The necessary additional help has been provided on the research side by the appointment of three Assistant Recorders, Messrs. Shaw, Clothier and Thompson, each of whom has had previous experience of the pomological work as members of the plantations staff. On the cultural side it has been necessary to alter the character of the post of Fruit Foreman. The work attached to this post has increased considerably owing to the developments of recent years and this opportunity has therefore been taken to divide the duties, part of which have been left in the hands of Mr. H. Locke, who has hitherto held the post, and the remainder taken over by his successor as Fruit Foreman, Mr. E. J. Young, a newcomer to the staff. The latter is concerned under the new arrangement solely with the cultural work of the plantations and the management of the labour staff required for that work, while Mr. Locke continues to carry on the remaining duties formerly attaching to the post and in addition becomes the Official Guide to the Station, a new appointment much needed in view of the continuous increase in the number of visitors to the Station.

Mr. J. E. Wells, N.D.A., Chemical Assistant in the laboratory since 1923, accepted a commercial appointment early in the year and has been succeeded by Mr. A. N. Dunsby, B.Sc., A.I.C., from the Chemical Department of the University of Bristol.

The period of study at the Station of Mr. H. D. Bennett, M.Sc., a holder of a Horticultural Studentship of the Ministry of Agriculture, terminated early in the year. He has now secured an appointment at the John Innes Institute.

The special investigation on the composition of tar oil spray fluids carried on during 1926 by Mr. L. E. Smith, Ph.D., resulted in the preparation of new spray mixtures, trials of which under a special grant from the Ministry of Agriculture had to be completed after his departure to Germany by Messrs. Tutin and Lees with the assistance of Mr. A. Wilkins, a member of the assistant laboratory staff. An account of those trials prepared by Mr. Tutin is included later in this Report.

Miss Kathleen Johnstone, Bathurst Student of Newnham College, Cambridge, began a year's course of post-graduate research in August, taking as a subject for investigation certain factors influencing the degree of resistance of varieties of apples to the Apple Scab fungus, *Venturia pomi*.

Mr. Hans R. Hansen, of The Statens Plantepatologiske Forsg, Lyngby, Denmark, who was making a tour of Agricultural Advisory Centres in Holland in 1927 by means of a scholarship awarded by the Royal Agricultural College, Copenhagen, spent a period of one month at the Institute during July and August. As Mr. Hansen's duties in Denmark are analagous to those of the Station's Advisory Officers in Economic Entomology and Economic Mycology, his time was devoted mainly to studying the particular problems on which these officers were engaged and their methods of attacking them.

Mr. Richard Wellington, Research Associate at the New York State Agricultural Experiment Station, Geneva, New York, U.S.A., also spent a fortnight at the Station during June for the purpose of studying the work in progress on rootstocks and plant breeding.

Under the new scheme already referred to, for which a grant from the Empire Marketing Board has been obtained, the following three appointments have been made. Mr. V. L. Smith-Charley, B.Sc., a member of the chemical staff of the Berkeley Square Advisory Centre, has been appointed for bio-chemical investigations. Mr. J. O. Jones, M.Sc., from the North Wales Advisory Centre at University College, Bangor, has been appointed Soil Analyst. Miss U. Tetley, B.Sc., from the Botanical Department of the University of Leeds, is conducting for a period of twelve months an investigation on the developmental anatomy of the apple. In the case of her researches and also those of Dr. Swarbrick the Station is fortunate in securing the co-operation of Professor J. H. Priestley, Head of the Botanical Department of Leeds University. The Station is similarly fortunate in obtaining the co-operation of Dr. Cyril West, of the Low Temperature Research Station at Cambridge University, in the fruit storage trials which are required in connection with this scheme.

Land and Plantations. There has been no change in the position indicated in last year's Report regarding the provision of suitable land for the extension of the field experiments on fruit culture. When the planting of the various plots required for experiments already planned is completed, practically the whole of the land belonging to the Station available and appropriate for this class of work will have been absorbed. There still remains an extensive programme of field trials, arising from past and current investigations at the Station, which there seems little chance of putting into operation in the near future. The point has been reached when it has been necessary to clear two of the oldest tree fruit plots, which had outlived their utility for experimental purposes, to make room for additional trials with soft fruits. For similar reasons the older trial plots of seedling fruits are being reduced as quickly as the cropping tests permit.

The largest new plot for which provision has been made during the year is one of approximately 12 acres, which will be devoted to trials of the selected " free " apple stocks, which Mr. Spinks has now secured in sufficient numbers by means of vegetative propagation. The main trial on this plot will be that of trees grown as standards and the plot will be divided into two halves, the one being treated as a grass orchard and the other cultivated. During the early life of the latter there will be room by interplanting for trials of the same stocks used for bush trees and also for field experiments with bush fruits. On account of the large acreage required for the tests with the trees grown as standards the land available at the Station will be inadequate for testing all the stocks selected during the course of the investigations on " free " stocks, which have been in progress since 1913. An effort is therefore being made to arrange for supplementary trials at suitable centres elsewhere, in the first instance in the Bristol Province and later in other important fruit growing areas.

The renewed interest in cider orchards has led to arrangements for the planting of a further series of trial and demonstration orchards throughout the Bristol Province and the adjacent cider-making counties on lines somewhat similar to those followed in the early series, which date from 1908 onwards. The number of trees raised in the nurseries of the Station available for planting during the 1927-28 and 1928-29 seasons is small, but many more should be available for distribution subsequently. During the course of the year there has been an opportunity of making a detailed survey of the older orchards planted under the original scheme, the results of which are included in the present Report.

Other trial plots of apple trees planted during the year at the Station include one required in connection with the work under the Empire Marketing Board Scheme. This will be under differential manurial treatment, designed to show the effects of farmyard manure on the one hand and of deficiencies of the various essential nutrient elements on the other hand. The variety of apple used is Lane's Prince Albert, planted on the Doucin stock (Malling Type II). The extent of the plot is $1\frac{1}{5}$ acres.

A new one acre plot of black currants is being mainly devoted to a field trial on the control of " reversion " and " big bud." Included in this trial also is an experiment on methods of pruning. The remainder of the plot is being appropriated for a comparative test of two new seedling varieties of black currants against the varieties Baldwin and Boskoop Giant, which are taken as representative types for comparison. The test is being duplicated at Wisley and East Malling and forms a part of the Wisley Variety Tests Scheme. One of the points in this trial to which special attention will be given is that of the experimental error incidental to field trials of this fruit.

In addition to the foregoing a plot of black currants, planted with two-year-old bushes of the Hilltop type of Baldwin, kindly given by the Trustees of the Bickham Estate, has been provided for a series of manurial trials.

In connection with the strawberry investigations which the Station has had in hand during the past few years, various new plots have been planted up. These are chiefly concerned with specific pathological problems. A second successional planting has been made on the series of plots devoted to the manurial tests of deficiencies of the respective essential nutrient elements.

Additions have been made during the year to the respective trial plots of raspberry varieties, various fruit seedlings, and willow varieties.

The Institute now functioning as a Sub-Station under the Wisley Fruit Tests Scheme, the new varieties already selected for distribution under that scheme have been planted in appropriate plots.

Buildings. During the year the extension of the laboratory building referred to in the Report of last year has been carried out. The new wing is already partly in use and will be fully occupied early in 1928. The new building includes a room of suitable size for the holding of Conferences and other meetings, a need which has been apparent since the establishment of the Station and very pressing during recent years.

A series of special buildings and structures is required for the new work under the Empire Marketing Board Scheme. Plans for these have been prepared and erection will be proceeded with early in 1928. Among the buildings required is a fruit store for the storage tests at ordinary temperature. It has been possible by suitable alterations to adapt for this purpose one of the existing Fenswood Farm buildings, which has recently been in use for general storage of apples and pears. As modified according to the recommendations of Dr. Cyril West, based on his experience from the trials of various forms of fruit stores conducted by the Food Investigation Board, it promises to make an exceptionally satisfactory store of the most up-to-date ventilated type.

General. The Annual Tasting Day, held as usual on the first Thursday in May, proved a record-breaking function in nearly all respects. The attendance was easily the largest yet recorded, and probably exceeded 1,000 during the course of the day, since over 700 names were entered on the visitors' lists. To what extent the Cider Competitions, then in their second year, proved the attraction responsible for the large increase in number of visitors it is impossible to say, but there is no doubt as to the wide degree of interest which they have aroused, and this should be reflected in due course in a general improvement in the condition of farm orcharding and in the quality of fruit produced for the cider industry.

On June 29th an Open Demonstration Day was arranged on similar lines to the series held during the course of 1925. The more interesting features of the work visible at that time of the year, including the variety trials of the various soft fruits, were demonstrated to the visitors. It was intended to hold a second Open Day during September, to be concerned mainly with the tree fruits, but the continuous spell of bad weather during the summer and early autumn led to the idea being abandoned.

On the same day the adjourned Annual Meetings of the Governors and Members of the National Fruit and Cider Institute were held at the Station, so that the subscribers to the Institute might have a convenient opportunity of being shown something of the work at a time of year when they can see features of interest which are usually missed at the time of the Annual Tasting Day and other functions at the Station. Hitherto these meetings have taken place in the Bath and West Showyard at the time of that Society's Annual Show. In view of the appreciation of this new arrangement it is hoped that it will be possible to continue it regularly in future, in which case the Annual Meetings, which under the Articles of Association of the Institute must be held in the Bath

and West Showyard during the Show, will serve there solely for the transaction of formal business and will be adjourned for the subsequent meeting at the Station.

Apart from these occasions when the Station was thrown open to visitors generally there was the usual series of visits by organised parties. Of special interest was that paid at the beginning of November by a group of members of the Imperial Agricultural Research Conference, most of whom were directly interested in the subjects of fruit culture and products or plant pathology. The complete list of these parties for the year is as follows :—

Bristol University Chemical Society.
Bristol Education Committee's Gardening Classes.
Imperial Agricultural Conference.
The Workers' Educational Association.
Messrs. J. S. Fry & Sons' Trades Welfare Section.
Worcestershire Farmers' Union Fruit and Vegetables Committee.
Colston's Girls' School Science Class.
Saltford Women's Institute.
Bristol Grammar School Scientific Club.
Bristol University Summer School.
Midsomer Norton & District Gardeners' Debating Society.
Hotwells & District Allotments Association, Ltd.
Messrs. J. S. Fry & Sons' Trades Welfare Section.
Wilts Teachers' Class.
Bristol Post Office Retired Officers' Association.
Library & Club of Messrs. Braby & Co. Ltd.
Dursley Branch of the National Farmers' Union.
Pershore Progress Club.
Party from Kingswood.

As usual, several exhibits illustrating the work of the Station were staged at various Shows during the year. In some cases the exhibit was a composite one, covering the advisory side of the work at Long Ashton and that of the Berkeley Square Advisory Centre and also in a few instances that of the Campden Station in addition. The Shows to which exhibits were sent were as follows :—

Bath & West & Southern Counties Show, Bath.
Exhibition of Handicraft Work, Maidstone.
" " " Chichester.
Produce Exhibition, Exford.
Wilts County Agricultural Show, Devizes.
Royal Isle of Wight Show, Newport.
Royal Agricultural Society of England Show.
Cheltenham Spa Floral Fete, Cheltenham.
Three Counties Show, Worcester.
Devon County Show, Paignton.
Meeting of Members of the National Canning Council, Cardiff.
Exhibit with " marketing " bias for Ministry of Agriculture and Fisheries.
Lincolnshire County Agricultural Show, Spalding.
Brewers' Exhibition, London.

There has again been a wide demand for special lectures to be given by members of the Staff. This demand has not been confined to the counties comprising the Bristol Province : it has come

also from the other leading fruit growing areas. The lectures in special request have been on subjects particularly identified with the work of the Station, such as the nutrition of fruit trees, the culture and diseases of the strawberry and other fruits, farm orcharding and cider making, and willow growing. The attendances have been very satisfactory in nearly all cases. Interesting discussions have followed, which have led to a closer touch with the problems of the districts visited.

This evident desire on the part of fruit growers to obtain first-hand knowledge of the work upon which the Station is engaged has been shown also by the demand for the various publications which have been issued by the Station. The reserve stock of some of the Annual Reports and reprints of papers has already been exhausted and larger supplies will evidently be needed in future. A corresponding desire has been shown in various ways by research workers on horticulture and related subjects at home and abroad. Mention has already been made of the increase in the number of overseas visitors. In addition to the representative group forming the party from the Imperial Agricultural Research Conferences, the Station has been visited during the year by prominent workers and officials representing areas as scattered and remote as Canada, the United States, the West Indies, South Africa, Australia and New Zealand, Japan and various parts of Europe. A strong desire has been expressed in many cases for return visits from members of the Staff to examine the respective local conditions and problems on the spot. Developments in this direction have been foreshadowed during the proceedings of the Imperial Agricultural Research Conference. The benefits to be gained by such interchange of visits are so generally recognised that they need not be enlarged upon here.

The scheme for the provision of local instruction in cider making, in which the counties of Dorset, Monmouth, and Worcester are jointly concerned, has been in full operation throughout the year. An account of the work is given elsewhere in this Report by Mr. P. T. H. Pickford, the Instructor in Cider making. It is believed that already it has been successful in improving the standard of cider making on the farms visited and on several occasions appreciation of the services rendered by the Instructor has been received.

The Cider Competitions initiated at the Institute in 1925-26 and fully reported upon in the Report for 1926 were repeated on similar lines during the season 1926-27. The results are dealt with in detail later in the present Report. In spite of another relatively poor cider fruit crop the number of entries was nearly double that of the first Competition. The judges on this occasion were Messrs. W. D. McCreath, J. W. Pullin and A. L. Sadler. General satis-

faction with their awards in a very difficult task was freely expressed when the ciders were exhibited on the Annual Tasting Day and the warmest thanks of the Institute are due to them for their services, so generously given.

A new feature in the work of the cider department occurred during the course of the summer as a result of a visit paid to the Institute during the previous winter by Mr. F. L. MacDougall, the representative of Australia on the Empire Marketing Board, and Mr. T. W. Gepp, of the Department of Development and Migration of that country. Possible outlets for Australian apples of the lower grades have been under consideration and, as a result, the Institue offered to carry out a test of their value for cider making. The Australian Government, in accepting the offer, arranged for a consignment of representative varieties from Tasmania, and this fruit on arrival in July was then made into cider by the standard English methods.

The association of the Institute with various other centres in conjoint work, recorded in detail in the 1925 Report, has been continued and in some cases extended. Specific mention of the following is called for.

The third annual joint meeting of the staffs of the East Malling and Long Ashton Institutes was due to be held at Long Ashton in the autumn of 1927. Owing to the numerous staff changes and recent additions it was decided to defer it until the spring of 1928. In the meantime the conjoint work previously referred to has been proceeding actively and, in addition, material assistance has been rendered in the investigation of various local problems in the South-Eastern area in cases of chlorosis, leaf scorch, and other soil difficulties, and of strawberry pathology.

The fourth annual joint meeting of the research, advisory and educational staffs of the Harper-Adams and Bristol Provinces was held in July at the Harper-Adams College. An apology is due to the Harper-Adams representatives at the absence of representatives of the Long Ashton Institute owing to the impossibility this year of arranging a mutually convenient date. The University of Bristol was, however, represented by the members of the Berkeley Square Advisory Centre.

The Surveys of Fruit Soils undertaken on behalf of the Ministry of Agriculture in conjunction with members of the staff of the Department of Agriculture of Cambridge University have been continued during the year. The Joint Committee responsible for the Surveys has been extended by the inclusion of representatives

of the South-Eastern Agricultural College, Wye, and the East Malling Station in view of the arrangement of a new survey in the South-Eastern area by members of the staffs of those institutions. Monographs on the first two surveys, in the West Midlands and East Anglia respectively, completed in 1926, have been prepared and will be published in the series of Research Monographs issued by the Ministry of Agriculture.

The low-temperature fruit storage tests associated with the two latter surveys and arranged in conjunction with the Food Investigation Board are being continued over a period of years. They are being supplemented by other storage tests at ordinary and low temperatures of apples examined in connection with the Empire Marketing Board Scheme previously referred to. The Institute and the Food Investigation Board are jointly responsible for the conduct of these tests, and members of staff of the latter body are taking an active part in the recording of results.

A trial of varieties of Willows is being arranged by the Somerset County Council in association with representative willow growers of the County and the Willow Officer of the Station. Two acres of land for the purpose of these trials have been offered by growers in the Somerset willow-growing area and it is hoped that arrangements can be completed in time for the planting of the plots during the current planting season.

Berkeley Square Advisory Centre.

The work at Berkeley Square continues to expand and now covers a much wider field than was contemplated when the centre was first established. A point has already been reached in the case of the older branches where further expansion will only be possible by additions to the staff, the existing members of which find the task of coping with all the demands for their services an impossible one. There appears little prospect of the necessary corresponding increase in grants from the Ministry of Agriculture. While it is gratifying that in so short a space of time the Centre should have thus fully justified its establishment and have demonstrated the need for advisory assistance of this kind in the Bristol Province, those who desire help from it are asked to recognise that without increased resources staff limitations will make it inevitable that some enquiries must be subject to some delay in attention. They may be assured that every effort is made to deal with their problems as promptly as circumstances permit.

An important development affecting the Chief Advisory Officer, Dr. J. A. Hanley, has occurred during the year. The post of Principal of the Royal Agricultural College, Cirencester, having become vacant by the resignation of Professor M. J. R. Dunstan, M.A., the Governors of the College, which is associated with the University, have arrived at an arrangement with the University under which Dr. Hanley has been appointed to succeed Prof. Dunstan as Principal, at the same time retaining his post as Chief Advisory Officer for the Bristol Province. He becomes at the same time Professor of Agriculture in the University. This strengthening of the link between the College and the University will, it is hoped, enable both bodies to provide more adequately than hitherto for the needs of the Bristol Province in respect of agricultural education.

The other staff changes to be recorded are as follows :—

Mr. C. A. MacEacharn, B.Sc., as Dairy Bacteriologist in place of Mr. H. R. Jones.

Mr. W. R. Muir as a full-time Chemist to assist the Advisory Chemist in place of Mr. V. L. Smith-Charley, B.Sc., who obtained an appointment as Bio-Chemist at Long Ashton.

Mr. C. W. Linley, N.D.A., to supervise the sugar beet demonstrations carried out under the Ministry of Agriculture's Scheme in the Western Province.

Mr. R. S. Critchley, M.A., to assist with the investigation into cost of production of sugar beet in the Western Province.

The two last-named appointments represent new developments in the work of the Centre arising from the increasing attention which is being given to the cultivation of sugar beet in this country.

A further reference to the work of the Centre will be found in the Advisory Section of this Report and nothing more need be added here except a cordial acknowledgment of the assistance rendered from time to time by other Departments of the University, and in particular the Chemical Department, with which the work generally is most nearly associated.

Campden Research Station.

Owing to possible impending changes affecting the future of this Station, there is little to record in the shape of new developments of work or equipment. On the other hand, the Station has been very fully occupied in consolidating the position which it has earned during the past few years as the advisory and research centre for the young and rapidly expanding canning industry in this country. With this industry in its present stage of development

it is natural that the most active functions of the Station should be at present in the direction of advisory, demonstrational, and educational work and thus there has been relatively little time available for the staff to concentrate on the research problems which it has in hand.

The position which the Station has attained as an Advisory Centre for the industry is illustrated by the application made at the beginning of the year by the de Beers Consolidated Co., Ltd., of South Africa, for Mr. Appleyard, the Resident Director of the Station, to be permitted to visit that country and advise the firm in the fruit preservation operations conducted at the Rhodes Fruit Farms, a subsidiary undertaking of the Company. The services of Mr. Appleyard were placed at its disposal for a period of two months. Shortly after his return, he received an offer from the Company of the position of General Manager of this preservation factory, which he accepted. On the termination of his appointment at Campden, Mr. F. Hirst, the Micro-biologist of the Station, was appointed Acting Resident Director.

The only other staff change to record is the appointment of Mr. W. B. Adam, M.A., A.I.C., as Assistant Chemist in place of Dr. F. J. Paton.

The feature of the advisory work during the year has been, as already indicated, the amount of attention given to commercial canneries which have recently begun operations. Most of them are using the most modern forms of American canning plant, similar to that installed a year ago at the premises of the British Fruit Packing Co., Ltd., at East Farleigh, near Maidstone, for the purposes of the apple canning demonstrations undertaken by this Station. These demonstrations, which had to be largely deferred for a year owing to the failure of the apple crop in 1926, have been completed under more favourable conditions during the autumn of 1927.

The staff of the Station has been closely associated with the work of the National Canning Council and has rendered assistance on matters of a technical character. Sir Edgar Jones, K.B.E., Chairman of the Council, visited Campden during the course of the summer to see the work in progress and give an address on "The Canning Industry and its Prospects," to the students taking a course of instruction at the time.

The number of enquiries dealt with during the year ending September 30th, 1927, was 413.

During the fruit season five courses of instruction were given, as compared with four in the previous year. The number of students attending the courses has increased considerably, and applications have had to be refused owing to lack of accommodation. Fifty per cent. of the students were teachers of Domestic Science, who represented the principal domestic science colleges in England, Scotland and Wales. The remaining students were composed of Horticultural Instructors, Members of Women's Institutes and private individuals.

Eight demonstrations on canning and bottling were given to Women's Institutes in Gloucestershire and neighbouring counties. The number has decreased considerably this year owing to the fact that the Gloucestershire, Warwickshire and Oxfordshire Federations of Women's Institutes have sent students to take a course, so that they might be enabled to give demonstrations to Women's Institutes in their respective counties. A lecture was given to the Young Farmers' Club at Faringdon, Berkshire, and it is hoped that a series of demonstrations may be arranged for the Young Farmers' Clubs next season.

Judging of exhibits was undertaken under the auspices of the Gloucester, Warwick and Oxford Federations of Women's Institutes and of the Worcestershire Root, Fruit, Grain and Flower Society. Detailed reports of the judging have been sent to the respective Committees and, as the chief points of criticism are circulated to the exhibitors, such reports have been found helpful. Exhibits of bottled and canned fruits, apart from those loaned to horticultural lecturers and others, were shown at the Bath and West Show and the Three Counties Show, both of which exhibitions resulted in a number of students enrolling for a course of instruction.

There has been a great demand for the leaflets published by the Campden Station on the subject of the home preservation of the various fruits and vegetables, and it is intended shortly to issue a further series on the preparation of chutneys, the preservation of apples, the preservation of vegetables and candied, crystallised and glacé fruits.

FIELD EXPERIMENT ON THE MANURING OF GOOSEBERRY BUSHES.*

By T. Wallace.

A field experiment on the manuring of gooseberry bushes has been in progress on one of the Research Station plots since February 1921 and, as some very marked results have been observed from certain of the treatments from an early stage in the experiment, the data obtained for the seasons 1921 to 1926 inclusive have been analysed and a report on the experiment including these has been published. In the present paper, a summarised account of some of the more salient features of the results is given.

The area utilised for the experiment is approximately one acre in extent, and was divided into sixteen plots for the various manurial treatments. Eight manurial treatments were given, each treatment being given in duplicate.

The manurial plots were arranged in strip fashion and were numbered consecutively across the area from 1 to 16. Plots 1 to 8 comprised Series A. and plots 9 to 16 Series B.

The soil varies across the area in the general direction from plot 1 to 16, being heavier in Series A. than in Series B.

The details of the manurial treatments under the original scheme are given in Table I.

Table I.

Plot Nos.	Manurial Treatments.
1, 9	No manure.
2, 10	Dung at 10 tons per acre, each Spring.
3, 11	Complete "organic" manure (non-bulky), each Spring—to supply Nitrogen, Phosphorus, Potassium.
4, 12	Complete "inorganic" manure, each Spring—to supply Nitrogen, Phosphorus, Potassium.
5, 13	Complete Manure: Mixture of "organic" and "inorganic" materials in equal parts, each Spring.
6, 14	As 5, 13, less Nitrogen, each Spring.
7, 15	As 5, 13, „ Phosphorus, „ „
8, 16	As 5, 13, „ Potassium, „ „

* A full account of this experiment is given in "Journal of Pomology and Horticultural Science," Vol. VI., No. 3, Sept., 1927.

Notes.

Ingredients of the "organic" manure were dried blood, steamed bone flour and sulphate of potash and of the "inorganic" manure, sulphate of amonia, superphosphate and sulphate of potash.

Manures were calculated to supply nitrogen at 50 lbs. per acre; "total phosphates" at 120 lbs. per acre; potash (K_2O) at 50 lbs. per acre.

Diversions from the scheme have been as follows:—

1924, 1925—Muriate of potash was used vice sulphate of potash.

1924 onwards—On plots receiving potash, the rate was at 100lbs. K_2O per acre.

1925, 1926—Nitrate of soda was used vice sulphate of ammonia.

Results.

During the course of the experiment, careful notes were made relative to points of difference in the growth features of the bushes undergoing the various treatments. The chief points observed were as follows:—

1. During the earlier stages of the experiment, practically every bush on the area was badly affected with leaf scorch. Scorching was initially more severe on the lighter soil area than on the heavier soil area. In the later stages, severe cases of leaf scorch were confined to plots 8, 9, 16.

2. No definite starvation symptoms due to nitrogen or phosphorus deficiency were observed on any of the plots.

3. Defoliation was premature, following leaf scorch, on plots 8, 9, 16, and was slightly delayed by the dung treatment on plots 2, 10.

4. In Series A. where the soil is heavier than in Series B, there has been a tendency to a downward gradient in growth in the direction from plot 1, where the soil is heaviest, to plot 16, where the soil is lightest, and the bushes in Series A. have made better growth than those in Series B.

Quantitative data obtained relative to prunings, (as a measure of the growth of the bushes) leaf scorch, (seasons 1924 to 1926 inclusive) and cropping (seasons 1922 to 1926 inclusive) are summarised in Tables II, III, IV, which serve to show how the bushes have been affected by the manurial treatments and by soil variation.

TABLE II.

PRUNINGS.

Series.	Plot No.	Winter 1924-25.				Winter 1925-26.				Two Seasons.		
		Weights of prunings. Kilos.	No. of bushes.	Average weights prunings per bush Kilos.	Order of Weights	Weights of prunings. Kilos.	No. of bushes.	Average weights prunings per bush. Kilos.	Order of Weights	Totals of Average bush. Kilos.	Order of Weights	Percentage of Un-manured.
A.	1	5.19	40	0.130	4	11.14	39	0.286	5	0.416	5	100
	2	9.02	40	0.226	1	17.44	40	0.436	2	0.662	1	159
	3	5.46	40	0.137	3	17.10	39	0.438	1	0.575	2	138
	4	7.33	40	0.183	2	14.62	38	0.385	4	0.568	3	137
	5	5.07	39	0.130	4	15.30	39	0.392	3	0.522	4	125
	6	4.18	38	0.110	6	10.00	37	0.270	6	0.380	6	91
	7	3.98	40	0.100	7	9.90	38	0.263	7	0.363	7	87
	8	2.29	40	0.057	8	3.60	40	0.090	8	0.147	8	35
B.	9	3.04	40	0.076	7	4.16	39	0.107	7	0.183	7	100
	10	5.23	40	0.131	1	11.36	38	0.300	1	0.431	1	236
	11	3.05	39	0.078	6	7.87	37	0.213	4	0.291	4	159
	12	3.96	39	0.102	3	10.46	39	0.268	2	0.370	2	202
	13	4.18	39	0.107	2	9.11	37	0.246	3	0.353	3	193
	14	3.25	38	0.086	5	6.53	34	0.192	5	0.278	5	152
	15	3.78	40	0.095	4	6.64	38	0.175	6	0.270	6	148
	16	1.02	37	0.028	8	1.91	35	0.054	8	0.080	8	44

TABLE III.

LEAF SCORCH.

Series.	Plot Nos.	27/6/24	23/6/25	26/8/25		21/6/26
		Nos. of affected bushes.	Nos. of affected bushes.	Total Nos. affected bushes.	Nos. seriously affected.	Nos. of affected bushes.
A.	1	0	0	36	10	0
	2	3	1	17	2	0
	3	4	1	16	0	0
	4	1	1	12	0	0
	5	3	0	8	0	0
	6	0	2	15	0	0
	7	2	4	19	1	0
	8	28	28	38	32	31
B.	9	26	24	34	30	25
	10	10	6	23	11	2
	11	7	7	22	9	1
	12	11	5	15	3	2
	13	4	5	18	5	4
	14	8	4	19	5	2
	15	3	5	24	0	1
	16	35	27	35*	26	26

* Also Total No, bushes on Plot.

TABLE IV.

CROPPING DATA.

Series.	Plot Nos.	Season 1922		Season 1923		Season 1924		Season 1925		Season 1926		Period 1922-26		
		Average per bush. Kilos.	Order of Cropping.	Average per bush. Kilos.	Order of Cropping.	Average per bush. Kilos.	Order of Cropping.	Average per bush. Kilos.	Order of Cropping.	Average per bush. Kilos.	Order of Cropping.	Totals of average bush. Kilos.	Order of Cropping.	% of unmanured.
A.	1	0.0590	1	0.3408	6	1.1928	1	1.7771	7	1.7429	1	5.1126	1	100
	2	0.0335	5	0.3635	3	1.0350	2	2.1282	2	1.5342	2	5.0944	2	100
	3	0.0570	2	0.3708	2	1.0100	4	2.1294	1	1.2986	4	4.8658	4	95
	4	0.0458	3	0.4913	1	1.0343	3	2.0339	4	1.3024	3	4.9104	3	97
	5	0.0305	8	0.7497	5	0.8873	7	2.1209	3	1.2266	6	4.6154	5	90
	6	0.0390	4	0.3508	4	0.9141	6	1.9876	5	1.2503	5	4.5418	6	90
	7	0.0335	5	0.3073	7	0.9958	5	1.8709	6	1.2009	7	4.4084	7	86
	8	0.0310	7	0.2738	8	0.6270	8	0.8721	8	0.7711	8	2.5749	8	51
B.	9	0.0260	7	0.3614	6	0.8727	6	1.1543	5	1.0971	7	3.5115	6	100
	10	0.0280	3	0.4195	3	0.9641	4	2.1150	2	1.3770	5	4.9036	3	140
	11	0.0280	3	0.3686	5	1.0086	3	2.2056	1	1.6925	2	5.3033	1	151
	12	0.0280	3	0.4941	2	1.0460	1	2.0324	3	1.5271	3	5.1276	2	146
	13	0.0410	1	0.4955	1	1.0295	2	1.3795	4	1.6995	1	4.6450	4	132
	14	0.0295	2	0.4091	4	0.8967	5	1.1088	6	1.5031	4	3.9472	5	113
	15	0.0270	6	0.3236	7	0.7750	7	0.7142	7	1.3153	6	3.1551	7	90
	16	0.0210	8	0.0932	8	0.2371	8	0.0524	8	0.3400	8	0.7437	8	21

Conclusions.

The main conclusions which have been drawn from the data are as follows :—

1. Considerable differences found in growth and cropping of the bushes are attributable to soil variation. The soil on the heavier areas is more suited to the growing of the bushes than is that on the lighter areas.

2. Substantial increases in growth and cropping have resulted from " dung," " complete organic " manure and " complete inorganic " manure on the lighter soil area. These manures have also increased growth on the heavier area. It is probable that increases have also resulted from nitrogen plus potash and " phosphates " plus potash.

   The increases in wood growth due to manures were relatively greater than were increases in cropping.

3. Detrimental effects on growth and cropping apparently resulted from manuring with " nitrogen plus phosphates only " on plots where bushes were exhibiting symptoms of potash starvation.

4. Potash is the limiting factor to the growth of gooseberry bushes on the area.

5. Potash manures did not exercise any controlling action on botrytis spread. Strongly growing bushes were affected most and weakly bushes showing potash starvation were only slightly damaged.

PROGRESS REPORT ON FRUIT BREEDING.

By G. T. Spinks.

Progress in the work of breeding fruit is necessarily slow. Even if the object is only to raise a number of seedling plants and to select any of outstanding value, a period of waiting until the seedlings bear fruit is inevitable. This period of waiting is particularly long in the case of the top fruits. Except in rare cases, the minimum age at which a seedling apple tree will fruit may be put at five years, but very frequently a tree may be two or three years older than this before it bears. Seedling plums and pears come into bearing at about the same age as apples, but the bush fruits commence to fruit much earlier, at three years of age, while good crops can be obtained from seedling strawberries less than two years after sowing the seed.

At Long Ashton, this preliminary time of waiting has now come to an end, even in the case of the top fruits, and large numbers of seedlings are coming into bearing each year. After the first selection of an individual seedling comes a period of propagation and trial of a larger number of plants of the selected variety. This phase of the work has just commenced in the case of apples, but trials of some of the selected soft fruits which have been propagated have been in progress for several years and are now yielding some information.

Further details of the work on the various fruits are given below :—

Apples.— Fruit was obtained this year from about 350 individual seedling trees. When the breeding work with apples was commenced a considerable number of "open-pollinated" seeds were sown, *i.e.*, seeds were obtained from known varieties of apples, but the apples had been pollinated naturally. The male parents of the seedlings obtained in this way are therefore unknown although the female parents are known. This course was adopted, firstly, in order to obtain quickly a number of seedlings and, secondly, to discover which varieties would show any dominance of their characters or would show their suitability for use as parents by giving rise to a large proportion of good seedlings. Later batches of seedlings are all the result of controlled pollinations and are usually crosses, although a small amount of self-fertilized seed has been obtained.

The majority of the seedlings which have already fruited are derived from the open-pollinated seed, and it is now possible to see how some of these families are behaving, although some members of the families have not yet borne fruit.

For instance, in one family obtained from open-pollinated seed of Bismarck about twenty trees have fruited. The fruits of all these trees have a considerable resemblance to each other and to Bismarck. There are differences in size, but as regards shape, colour and flesh characters there is a great similarity.

Another family, derived from open-pollinated seed of Lord Derby, contains about a dozen fruiting trees. The resemblance of all the seedling fruits to that of Lord Derby is very marked, and the habit of all the trees is also very similar.

King of the Pippins is another variety which appears to transmit the shape and other characters of its fruit to open-pollinated seedlings. This conclusion is drawn from only a few examples, however, as up to the present only a few members of the family have fruited.

The family of seedlings obtained from open-pollinated seed of Cox's Orange Pippin is in marked contrast to the above families. The fruits of about forty seedlings show the greatest diversity in size, shape, colour and flavour, and few of them bear any resemblance to Cox's Orange Pippin.

It is apparent that the various families of open-pollinated seedlings are now providing some information regarding the probable result of using certain varieties as parents when making crosses.

Various families of crosses are also beginning to bear fruit, but up to the present no large numbers of seedlings have fruited in any one family. Descriptions are being made of all the fruits and the trees which bear them.

The selection of promising new varieties is being continued and several have been found amongst the seedlings now fruiting. Of the two early dessert apples noted in the last Report, one bore no crop this year, but the other again cropped well, and the fruit was again of good quality though it did not appear to be as early in season as last year. This variety, however, seems to be well worth propagating and testing on a larger scale.

Three or four dessert varieties which follow Worcester Pearmain in season have been thought worthy of a further trial. They are attractive in appearance and flavour, and one of them is particularly promising.

Up to the present no late-keeping dessert apples of outstanding merit have been found, although two or three may be worth a further trial.

Quite a large number of good culinary varieties have made their appearance, but it is doubtful whether they are worth propagating in view of the number of good varieties of cooking apples which are already available to growers.

In selecting good new varieties from amongst the seedlings, particular attention has naturally been paid to the characters of the fruits, but before any new variety can be recommended for distribution it will be necessary to have more information concerning the vigour, health and cropping powers of the trees. This can only be obtained after a number of trees have been grown for a considerable period. This extended trial on a larger scale is the next step in the work of selection. Meanwhile it is hoped that further preliminary selections of promising new varieties will be possible each year as fresh seedlings come into bearing.

This year a few more crosses were made. The variety Mackintosh Red, which has proved to be so valuable a parent in the work of fruit-breeders in America, was used as a parent and was crossed with Worcester Pearmain, Cox's Orange Pippin and James Grieve.

Plums.—The plum seedlings are much less numerous than the apple seedlings, but a fair proportion of them have now reached the bearing condition. This year, 24, representing several different families, bore fruit, and of these 6 have been provisionally selected for further trial. One of these is a fairly early plum of good dessert quality, another is the heavy-cropping mid-season cooking plum noted last year, while a third is a good late cooking variety. The others are dessert or cooking plums of various seasons. More information regarding the growth, average crop and health of these trees is still required.

Pears. The first crosses with pears were made in 1920, and there are now about 150 seedlings in the plantations. This year, three of these fruited for the first time. The fruit of one, which is a cross between William's Bon Chretien and Conference, is of quite first-class dessert quality and was in season this year at the end of October. This variety will be propagated at once for further trial.

Black Currants.—A small trial plantation of selected black-currant seedlings bore its first crop this year. Records of crop weights were taken and several of these seedling varieties appear distinctly promising, as they bore heavy crops and the quality of the

fruit was also good. The size of the fruit varied in the different varieties. The best crops were obtained from mid-season varieties, none of the early or late varieties yielding particularly well. Some of the earliest were insufficiently protected from the attacks of birds, which took a considerable quantity of fruit, and severe storms caused the loss of more fruit. Possibly in another year the crop records of the early and late varieties may be better.

Records from this plantation will be continued for several years, and meanwhile the most promising varieties will be propagated in order to obtain them in larger numbers.

The above-mentioned seedlings are selections from some of the first to be raised at Long Ashton. A few years later, a second large batch of seedlings was grown and selections were made from these also. There are now in the nursery a large number of cuttings and young bushes propagated from the selected bushes of this second series in order to provide material for another trial plot.

One family of seedlings which is the result of a more recent cross has been planted out but has not yet fruited.

Gooseberries.—A few selected seedlings are being grown on and propagated for further trial. A number of other seedlings have been discarded after having been under observation for several years.

Raspberries, Blackberries and Hybrid Rubi.—Several selected raspberries have been included in a trial of standard varieties, and all the varieties on the trial plot bore their first crop this year. In the first one or two weeks of the picking season, some of the seedlings showed up well, being amongst the heaviest croppers, but the total crop for the season of the best of the seedlings was distinctly below that of the best three named varieties. The fruit of the seedlings was also small and poor in quality, and much inferior to that obtained when the selections were made. The dry weather of the spring of this year may have influenced these results, and comparative results may be different in another year, but certainly, except in earliness, the seedlings do not compare very favourably with the best named varieties this year.

A few selected raspberry seedlings are still undergoing a preliminary trial, and three more families of seedlings have not yet fruited.

The hybrid seedlings mentioned in the last Report are under observation, and the selected loganberries and blackberries are still under trial.

Strawberries.—The seedling varieties which have been selected in past years have, in common with many other varieties, suffered severely from aphis attack and other troubles. Many of them have practically died out or have been reduced to a very weak state, but those which are still vigorous are receiving a further trial.

The attack of the aphis *Capitophorus fragariae* has been shown to be the cause of one of the many troubles from which strawberries all over the country are now suffering. Mr. L. N. Staniland has suggested the names of several varieties of strawberry which he has found to be resistant to the attack of this aphis, and this year some of these varieties have accordingly been used in an attempt to breed improved varieties which are also resistant to aphis attack. The following families of seedlings have been raised :—

Aberdeen Standard	selfed.
,, ,,	× Royal Sovereign.
,, ,,	× Stirling Castle.
Dunbarton Castle	selfed.
,, ,,	× Royal Sovereign.
,, ,,	× Stirling Castle.
Sturton Cross	selfed.
,, ,,	× Royal Sovereign.
,, ,,	× Stirling Castle.
Tardive de Leopold	× Royal Sovereign.
,, ,,	× Stirling Castle.

The variety Tardive de Leopold could not be self-fertilized, as it is pistillate only and produces no pollen.

These families will be kept under observation and any promising individuals will be propagated.

THE RELATIONS OF SCION AND ROOTSTOCK.

By B. T. P. Barker.

I. Tree Size in relation to Scion and Rootstock.

(*a*) The Case of Young Trees.

Since the investigations on the various forms of apple rootstocks were begun jointly by the East Malling and Long Ashton Research Stations in 1913, the published records of the work have been concerned until recently mainly with the morphological characters of the different kinds of stocks and the classification of the individual sorts into a series of groups differing primarily from each other in degree of vigour of growth. The general effect has been to focus attention on the importance of raising trees on stocks of known character and to stimulate propagators to provide supplies of trees true to name as regards stock as well as scion. The selection of the kinds of rootstock for such use from among the many forms available has necessarily been so far of a rather arbitrary nature and must continue so until the comparative trials, already in progress, have yielded more complete results. Choice has been made from the members of the respective groups chiefly according to the degree of strength required ; for the purpose of the immediate work in hand it had to be tentatively assumed, pending direct proof or disproof, that the ultimate size of the tree produced would approximately correspond with the natural vigour of growth of the rootstock used.

Somewhat naturally, as a result of the emphasis placed on the advantages of using standardised stocks, there has been a tendency for some to regard the problem of stock influence as though the choice of particular types of stocks was the all-important matter. Those responsible for these investigations have, however, taken care to point out that stock selection only represents one phase of the question and constitutes a starting point for attacking the main problem of the nature of the inter-relation of rootstock and scion. The available results of the line of work to be considered in this paper indicate the justification of this attitude. It is not intended here to give more than a brief summary of the earlier stage of the work.

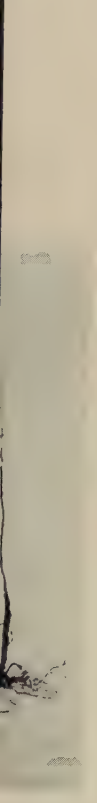
In the particular problem under investigation in this case, *viz.*,

Class 1.

Class 2.

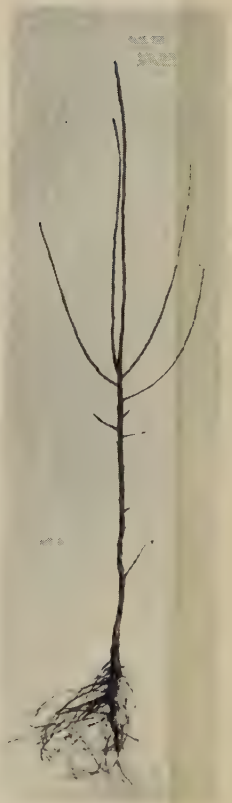
Class 3.

Cla



4.

Class 5.



Class 6.

Class 7.

Class 8.

TABLE I.

Class 10.

Class 11.

Class 12.

the relation between stock and scion in respect of the growth and cropping capacity of the composite tree, one of the main questions to be decided is that repeatedly propounded by pomologists. Does the stock dominate the scion in determining the size of tree, or is the scion the predominant partner ? Some evidence bearing upon it has already been published, a general outline of which has been given by Gardner, Bradford and Hooker (1), and special cases in a series of papers issued from the East Malling Station. It permits a partial answer, in that there is general agreement that certain of the reputed dwarfing stocks, *e.g.*, Jaune de Metz, (Malling IX.), exercise beyond any doubt a dwarfing effect and produce a smaller tree than a more vigorous rootstock under the same conditions. On the other hand it is improbable that on evidence hitherto available there would be general acceptance of the proposition that the growth of the tree is in direct relation to the vigour of the stock, whether the latter's influence be either dwarfing or stimulating. Yet, as already seen above, in stock selection work, hitherto, even when this proposition has not been tacitly accepted, it has had to be taken provisionally as a working basis.

Before it can be decided if a particular stock is dwarfing or stimulating for a given scion variety, some standard to serve as a basis of comparison is required. The obvious standard is that of the scion variety growing on its own roots. Unfortunately in the case of varieties of apples grown for the sake of their fruit such a standard presents serious difficulty. Many either cannot be rooted by ordinary methods of vegetative propagation or fail to form a root system sufficiently well developed to be capable of yielding a normal and healthy tree. Others can be rooted more or less well, but both methods and results from the point of view of the problem to be investigated are open to considerable objection. The writer in conjunction with Mr. G. T. Spinks of this Station, has repeatedly tried the various methods which have been advocated from time to time and has tested in those ways an extensive range of varieties. In no case were the results considered to be sufficiently above criticism to serve to furnish the kind of standard required for an investigation of this nature. Several seasons having been lost after the investigation was originally planned in unproductive attempts along these lines, it was eventually decided to give up for the time being the attempt to use commercial varieties, and in their place to select sorts possessing the requisite free-rooting capacity without regard to the nature of their fruit. Such kinds,

(1) Gardner, Bradford and Hooker. Fundamentals of Fruit Production. 1922.

many in number, were already at hand in the shape of the various forms which had been previously examined and approved, as possible rootstock varieties in the earlier selection of the stock investigations devoted to stock selection. By using such material the difficulty of providing reliable trees on their own roots to serve as the standards for comparison in the trials was overcome.

The plan of experiment ultimately adopted was as follows. Three varieties were chosen as types representative of different degrees of vigour of growth, *viz.*, (*a*) a "free" stock of very vigorous habit, discovered and propagated at Long Ashton many years ago and now known as Bristol V., (*b*) the Rivers' English Broadleaved Paradise, (Malling I.), representative of an intermediate grade of strength, and (*c*) the Jaune de Metz Paradise, (Malling IX.), one of the most dwarfing forms in common use. Each of these was used in the tests both as scion and rootstock in all the possible combinations. These included unworked trees of each as well as others where the stock was worked with a scion of the same kind, so that the effect of the union between stock and scion, if any, on the growth of the tree could be ascertained. In all, to cover every case of combination possible, twelve sets of trees were required for the trials, these being as follows :—

Class 1	Bristol V.	unworked (*strong unworked*).
,, 2	do.	on Bristol V. (*strong on strong*).
,, 6	do.	on English Broadleaved Paradise (*strong on intermediate*).
,, 10	do.	on Jaune de Metz (*strong on weak*).
,, 5	English Broadleaved Paradise	unworked (*intermediate unworked*).
,, 3	do.	on Bristol V. (*intermediate on strong*).
,, 7	do.	On English Broadleaved. (*intermediate on intermediate*).
,, 11	do.	on Jaune de Metz (*intermediate on weak*).
,, 9	Jaune de Metz	unworked (*weak unworked*).
,, 4	do.	on Bristol V. (*weak on strong*).
,, 8	do.	on English Broadleaved (*weak on intermediate*).
,, 12	do.	on Jaune de Metz (*weak on weak*).

The name of the scion variety is given first in each case. All stocks were of the same age when the experiment was started, being one-year rooted plants obtained from parent stocks by layering. Even-sized plants of each class were selected and the whole planted in a nursery row, and grafted according to plan *in situ* in March, 1923. They were left in the nursery quarters for two years after working, so that they might be ultimately planted out as two-year olds from the date of working. The unworked trees were the same as the worked in age of root system and were cut back to a corresponding degree when the others were headed back for grafting, so that no advantage should accrue on that account.

Results.

The results to be considered here are those obtained up to the time of removal of the trees from their nursery quarters in December, 1924. At that date the trees were planted up in their permanent positions.

The results since that time confirm generally those of the nursery period, but have been influenced by various disturbing factors, involved by transplantation and other causes. To avoid unnecessary complications of the issue in the present paper it is proposed to defer their consideration to a subsequent paper and confine attention to those of the nursery stage, which are definite enough to justify publication separately.

In this summarised account the records for individual trees will not be given in detail, the results being expressed as averages for the respective groups. A critical examination of the figures obtained by averaging may be necessary in the paper to follow, but the general conclusions which will be formulated in the present case are so well marked as to be undisturbed by the recognised weakness of the averaging method. This is clearly shown by the complete series of the trees illustrated in Table I., in which typical trees of each class are included.

The appended table shows the average weight, height and 1924 shoot growth per tree for each class. The number of trees of each class raised in the nursery varied from 10 to 23 and is stated in each case later in the paper.

AVERAGE GROWTH MEASUREMENTS.

Table I. Fig.	Class.	Height in cms.	1924 Shoot growth in cms.	Weight in grms.
(1)	Bristol V. unworked	196.6	476.6	701
(2)	Bristol V. on Bristol V.	179	442.5	637
(3)	English Broadleaved Paradise on Bristol V.	143	155.7	414
(4)	Jaune de Metz on Bristol V.	114	65.7	182.8
(5)	English Broadleaved Paradise unworked	155	191.4	416.9
(6)	Bristol V. on English Broadleaved Paradise	162	253.6	390.2
(7)	English Broadleaved Paradise on English Broadleaved	139	143	325.2
(8)	Jaune de Mentz on English Broadleaved Paradise	79	49	120.9
(9)	Jaune de Metz unworked..	107	62.8	160
(10)	Bristol V. on Jaune de Metz	145	213	437
(11)	English Broadleaved Paradise on Jaune de Metz	117.5	67.6	219.4
(12)	Jaune de Metz on Jaune de Metz ..	99	55.5	156.7

It is not intended to consider here these statistics in detail or the extent of variation of individual trees within each class. The salient conclusions on the main points at issue to be indicated are outstanding, in view of the relatively large differences shown by the average figures, which render detailed statistical analysis unnecessary. They are as follows.

(*a*) During the nursery period the unworked tree, on its own roots, is normally somewhat stronger than a tree produced by the grafting of a scion of the same variety upon a rootstock also of that kind. In other words, the presence of a graft union imposes some check to growth at this stage. The extent of the check was very variable in the series of trees under consideration here : in some instances it was so slight as to be almost negligible. Whether this effect is merely temporary and due to incomplete continuity of tissues of scion and stock for a time following the grafting operation, or is more permanent and brought about by a check to sap interchange between rootstock and scion at the graft union, is a point which can only be settled by the future behaviour of the trees.

(*b*) There is clear evidence that grafting a scion variety on a weaker-growing variety as rootstock results in the production of a smaller tree.

(*c*) The converse type of tree, *viz.*, one where the scion variety is weaker than the rootstock variety, is apparently sometimes slightly stimulated by the stronger rootstock, but the evidence is not conclusive and is open to criticism. Here again the future history of the tree must be ascertained to show whether the stimulation, where

it has apparently occurred, is temporary and caused by grafting on a strong root system already established, or is permanent and due to a regular forcing action of the stronger root variety.

(*d*) Where two varieties were interworked, *e.g.*, Bristol V. used as the scion variety on Malling I. as rootstock, and Malling I. used as the scion variety on rootstock Bristol V., there has been a big difference in the size of the trees produced, according to the way in in which the combination was made. In all cases, except that of the combination Bristol V. on Malling I., which will be considered presently, much stronger trees have been produced where the stronger of the two varieties in the combination was used as the scion. If the action between scion and rootstock were evenly balanced such combinations should at least have produced trees of the same average strength. Indeed, those with the stronger variety used as rootstock might have been expected to have been somewhat larger during the nursery history of the tree, on account of the more vigorous root system already established. The reverse in a very decided degree being the actual result, it must be concluded that the scion variety, whether strong or weak, exercises a much greater influence in determining the size of the tree than the rootstock variety.

The apparently exceptional case just referred to, that of the combination of Bristol V. on Malling I., is readily explainable. The group of trees with Bristol V. as the scion variety and Malling I. as the rootstock suffered severely from aphis attack in 1923, these with the Malling IX. on Malling I. group being the only trees in the whole series materially affected by the severe aphis epidemic of that year. As a result the leading shoots became badly twisted and distorted and subsequent growth heavily checked. Theoretically these trees should have been materially larger than those of Bristol V. on Malling IX., since Malling I. is a considerably stronger stock than Malling IX. Actually they were rather weaker. The difference in weight between them and the other set of the same combination, *viz.*, Malling I. as the scion on Bristol V. as the rootstock, is small and well within the limits of experimental error. Hence, had it not been for the aphis attack, it is legitimate to conclude that they would have been appreciably stronger and would have fallen into line with all the other cases.

(*e*) The relative dominance of the scion variety in determining the size of a tree is also clearly shown by comparing the various sets of figures obtained for either variety Bristol V., Malling I. and and Malling IX., when used as scion and stock respectively.

For example, where Bristol V., the strongest grower, was used as

the scion variety on Bristol V., Malling I. and Malling IX. respectively as rootstocks, the average weights per tree ranged from 637 to 390, according to which rootstock variety was used. Where, on the other hand, it was used as the rootstock with the same three varieties as scion varieties, the average weights per tree ranged from 637 to 182 according to which scion variety was used. In other words, for the three varieties with which it has been tested, the variation in size of tree obtained is not one-half as great when Bristol V. is used as a scion as when used as a rootstock.

Similarly for the weakest variety, Malling IX., the corresponding figures were 182 and 120 when used as a scion and 437 and 156 when used as a rootstock.

(*f*) Some idea can be formed as to the probable range of variation in tree size, resulting solely from scion and stock interaction in the case of the apple.

Bristol V. is one of the " strongest " kinds so far isolated which root freely under the usual methods of stock propagation ; Malling IX. is one of the " weakest." Hence the results for this pair in combination should furnish approximately the extreme proportions of stock and scion effect likely to occur in practice.

Bristol V. unworked and growing on its own roots gave a tree about $4\frac{1}{4}$ times as heavy as Malling IX. in corresponding condition. When Bristol V. was grafted on Malling IX., the weight of the scion Bristol V. tree was reduced from 700 to 437. When Malling IX. was grafted on Bristol V., the weight of the scion Malling IX. tree was increased from 160 to 182. (In neither case is the difference in original weight of the stock portion of the tree taken into account, although the extra weight of the Bristol V. rootstock is in itself sufficient to account for most, if not the whole, of the weight increment in the trees with Malling IX. as scion).

While, therefore, a very dwarfing stock may reduce the weight of a tree with an extremely vigorous scion variety by very nearly 50 per cent. as compared with the latter on its own roots, in the converse case of the very vigorous stock and very weak scion the increase in weight due to the stock is at the most in the region of 10 per cent. and, as already indicated, may be nil.

For practical purposes, therefore, so far as the tree of planting age is concerned, the rootstock used may result in a dwarfing effect, ranging from nothing to 50 per cent., but can give practically no increase in growth.

(*g*) A comparison of the heights of the individual trees in the various groups shows certain definite points :—

Of the 10 trees in Class 1 (Bristol V. unworked) 100% have attained a height within 10% of the tallest.
Of the 16 trees in Class 2 (Bristol V. on Bristol V.) 81% have attained a height within 15% of the tallest.
Of the 17 trees in Class 6 (Bristol V. on Malling I.) 88% have attained a height within 15% of the tallest.
Of the 23 trees in Class 10 (Bristol V. on Malling IX.) 91% have attained a height within 15% of the tallest.
Of the 10 trees in Class 5 (Malling I. unworked) 90% have attained a height within 10% of the tallest.
Of the 14 trees in Class 3 (Malling I. on Bristol V.) 93% have attained a height within 15% of the tallest.
Of the 13 trees in Class 7 (Malling I. on Malling I.) 85% have attained a height within 16% of the tallest.
Of the 21 trees in Class 11 (Malling I. on Malling IX.) 76% have attained a height within 15% of the tallest.
Of the 17 trees in Class 9 (Malling IX. unworked) 65% have attained a height within 29% of the tallest.
Of the 9 trees in Class 4 (Malling IX. on Bristol V.) 74% have attained a height within 22% of the tallest.
Of the 15 trees in Class 8 (Malling IX. on Malling I.) 53% have attained a height within 23% of the tallest.
Of the 15 trees in Class 12 (Malling IX. on Malling IX.) 33% have attained a height within 25% of the tallest.

There was thus in the first seven cases a well-marked degree of uniformity in height of the individual trees within any one class, with the eighth very little less regular. The last four were much less uniform, the tenth being, however, appreciably better than the other three. For uniformity in height, therefore, the scion variety clearly dominates the stock and, so long as the former is at least moderately strong, a level set of trees, as regards height, may be raised on any stock, even the weakest. If, however, the scion variety is a weak grower, trees very irregular in height will follow, even when the strongest type of stock is used, although the latter will give the most level results obtainable with a weak scion variety.

(*h*) Comparison of height and weight figures for individual trees of the same set shows remarkable divergency in results. Trees within 10 per cent. of each other in respect of height frequently give differences of 200 per cent. and sometimes over 300 per cent. in weight.

It is thus extremely misleading to estimate the growth performance of trees by height measurements only, for what may appear as viewed in nursery rows, a remarkably level lot of trees, may be as diverse in weight as another set of trees obviously irregular in height.

(*i*) A point of both scientific and practical significance was brought into prominence by the behaviour of the trees of Group 4. (Bristol V. as scion on Malling IX. as rootstock). In this group 13 of the 23 trees bore a crop of fruit in 1924, grafting having been done in the spring of 1923. The number of fruits varied from 4 to 26 per tree. No other trees in any series produced any fruit.

This result should be considered in conjunction with that obtained by Hatton (1), who reported a similar experience when Bramley's Seedling was grafted on Malling IX. It is well known that the latter as a dwarfing rootstock quickly brings varieties worked upon it into bearing.

It is significant that in these cases it is the ultra-vigorous variety brought into fruit in the second year, whereas the weaker forms as scions remained barren. Normally the strongest growers are regarded as difficult to bring into fruit until the trees are of some age.

If this result is accepted as indicative of the necessity of a very large difference in vigour between scion and stock—the former being the stronger—to produce precocious cropping through stock influence, it may be taken as suggestive of internal causes in the tree required to initiate flower bud formation. Kraus and Kraybill (2) have produced evidence showing a relation between the carbohydrate-nitrogen ratio in the tissues and the behaviour of the plant in respect of flower production, the latter tending to be more profuse when the carbohydrate content is relatively high. The trend of all the work at Long Ashton on the factors governing fruit bud formation is in the direction of the water content of the tree being also closely concerned, conditions favouring a relatively high water content resulting in comparatively strong vegetative growth and those associated with a low water content being followed by restriction of vegetative growth and an increase in blossom production. In the case here under consideration vegetative growth of the scion has been markedly restricted, especially as regards lateral shoots. The result has been the production of a series of short lateral spurs with a relatively large leaf area in the immediate neighbourhood of the terminal bud in each case, owing to the failure

(1) R. G. Hatton. Suggestions as to the Right Selection of Apple Stocks. R.H.S Journal, July, 1920.

(2) Kraus and Kraybill. Vegetation and Reproduction with Special Reference to the Tomato. *Oregon Agr. Exp. Sta. Bull.*, 149, 1918.

of the axis to elongate and separate the individual leaves by internodes of material length.

The precocious flowering can thus be accounted for by, firstly, the dwarfing of the tree under the low water-content conditions resulting from the weak rootstock and, consequently, the conversion of the terminal buds of the lateral shoots into flower buds coincident with the relatively high local carbohydrate accumulation resulting from the large leaf area directly serving those buds.

If this explanation holds good, it follows that the failure to form blossom in the other cases is attributable to the existence of a different relation between water content and leaf efficiency.

Conclusions.

It is evident from the individual results just recorded that tree size in the case of worked trees bears a direct relation to the degrees of natural " strength " or vigour of growth of the two varieties used as scion and rootstock respectively, the weaker of the two functioning as a limiting factor. The actual size of the tree produced is not, as already shown, uniform for a given pair of varieties, irrespective of which is used for scion and which for rootstock: it varies according to whether the stronger or the weaker variety serves as the scion, a bigger tree resulting in the former case.

To take a concrete example, assuming that it was possible to root by layering a " strong " variety like Bramley's Seedling and a weak variety such as D'Arcy Spice as freely as one of the usual rootstock varieties, and that a series of trees of both those kinds was raised by grafting scions of each on rootstocks of each, the results would be of the following order. The Bramleys worked on the D'Arcy Spice rootstock would be much smaller than Bramley on Bramley, but definitely larger than D'Arcy Spice on Bramley. The latter would be very little different from D'Arcy Spice on D'Arcy Spice.

That is to say, the size of a worked tree is approximately similar to that of a tree of the scion variety grown on its own roots, if the rootstock used is of a variety of equal or greater vigour: when the rootstock variety is less vigorous than the scion variety, the size of the tree falls short of that standard in proportion to the relative " weakness " of the rootstock variety. Expressed in another form, appropriately chosen rootstocks exercise a dwarfing influence on tree size, but even the strongest produce little or no real increase in the growth vigour of any scion.

Since the extent of " dwarfing " depends upon the degree of " weakness " of the rootstock variety in relation to the scion variety, precocity in fruiting is most quickly secured when the scion variety is the " stronger " and the gap in growth vigour between the two as wide as possible.

SOME PRELIMINARY OBSERVATIONS UPON THE INFLUENCE OF SCION VARIETY UPON THE ROOT GROWTH OF YOUNG APPLE TREES.*

By Thomas Swarbrick.

Recent research into the relation of vegetative rootstocks to the growth and fruiting of scion varieties has served to somewhat concentrate our attention upon one particular phase of this inter-relationship. As compared with observations upon the parts of the tree above ground level, observations upon root-growth and root character are extremely difficult to make. Leaves being the centres of photosynthetic activity in the plant, leaf products must serve as the initial source of food supply for the rest of the plant body. Because of differences in leaf area and distribution between varieties, one might expect that different varieties would have somewhat different root habits. It is also well known that certain varieties shed their leaves early in the autumn whereas others retain them much longer. The recent work by Knight (3), and Swarbrick (6), has emphasised the importance of the position of leaves and developing leaf buds. These are found to be associated with diameter growth in a way that was not previously recognised. These influences are shown upon the tree in a basipetal direction. That is, the effect upon radial growth is shown from above downwards. The beginning of the growth activity in spring and its cessation in autumn. food usage and its subsequent re-storage, all proceed from the apex of a stem downwards. It has been shown (6) that there is a distinct wave of food storage down the stem in autumn. This is clearly related to the presence and distribution of leaves. Root elongation growth also appears to be definitely related to this autumnal accumulation of food substances in the stem tissues. In view of the fact that there are these downward tendencies in woody stems, one might conceivably expect differences due to variety in a scion to be gradually impressed upon the root, seeing that the root is so dependent upon the stem portion for its nutrition.

* The data given in this paper are taken from a paper entitled, "The Relation of Scion Variety to the Character of Root Growth in Apple Trees," by R. H. Roberts and the present writer. The work there recorded was carried out conjointly by the authors in the Department of Horticulture, Agricultural Experiment Station, Madison, Wisconsin, U.S.A., and was first published in Research Bulletin 78 of that Station. In the present paper the data are used to discuss certain aspects of the rootstock and scion relationship with reference to the position in England. The plates are reproduced with the kind permission of the Director of the Agricultural Experiment Station, Wisconsin. My best thanks are accorded to Professor Roberts for assistance and generous help in many ways. Acknowledgment is also made of the receipt of a Ministry of Agriculture Research Scholarship while carrying out this work.

Mention was made earlier of the difficulties of observing root-growth and root character. What little work has been done upon the effect of scion upon root character is inconclusive and conflicting. Pickering (5) noted such an effect of scion upon root growth and recorded it as follows : " The nature of the scion, in the same way, appears to be generally without influence upon the development of the stock though there are some instances in which it affects this stock in much the same way as the stock affects the scion : one or two varieties of apples, *e.g.*, Tylers Kernel, when grown upon Paradise stocks, alter the habits of the roots to such an extent that they assume the deep rooting straggling characteristics of the crab stock." Hatton (2), however, from his own experimental work does not regard the available evidence as in any way decisive. Hatton's data, however, strongly suggest such influences associated with certain varieties. This suggestion is considerably strengthened by the assertion of some nurserymen that certain varieties are coarse rooters as against others that are relatively fine rooters. A definite influence of variety upon root character can be inferred from Hatton's work upon vegetative rootstocks. He states in the above paper that he specially selected for a particular purpose Malling Type I. because unworked it presented a well mixed balance of coarse root and fibre ; Type II. because fibre is always notably scanty ; and Type IV. because of its marked horizontal rootedness. These differences in root character between the Malling Types I., II. and IV. are varietal differences due entirely to the varietal nature of the scions, which in this case were the unworked Malling Types. Except by working on a fairly large scale conclusive evidence of the effect of scion upon rootstock is difficult to establish. The problem is further complicated in that except under rare circumstances one does not see any quantity of trees of several varieties out of the ground at the same time.

During the winter and spring of 1926-27, the writer had the opportunity to examine this particular relationship under very favourable conditions, namely in some of the larger nurseries in the Middle West of the United States of America. Conditions and practice are radically different in this part of America from conditions and practice in England. In the first place, the situation in the majority of the American nurseries is not complicated by the use of both vegetative and seedling rootstocks, for they use the latter entirely. The writer was in two nurseries which each made over five million apple grafts a year, and was in touch with a third which made ten million each year. In none of these nurseries were any trees worked upon vegetatively propagated rootstocks. The practice in these nurseries is to bench-graft. That is, one year old seedlings grown in the fertile valleys of Kansas and Missouri are

dug in autumn and sent in bundles to the various nurseries throughout the States. In the particular nurseries under notice, these seedling roots are then passed through the hands of a gang of boys who with sharp knives remove any lateral roots, leaving the long tap root looking like a long narrow carrot. It is the aim of the growers of these seedlings, and the desire of the nurserymen to obtain seedlings with long large unbranched tap roots. A selection of such roots is shown in Figure I. These trimmed roots are then severed from the tops well below the crown region and cut up into 5-6 inch pieces. A 5-8 inch scion piece is then grafted by means of a whip and tongue graft on to the root piece. The grafts are then tied and waxed and put away at a suitable temperature in order to callus. After callusing they are planted out in the nursery rows when conditions become favourable in spring.

Climatic conditions in the Middle West make it impossible either to lift or plant fruit trees between the middle of December and the middle of February. As a consequence, trees intended for planting in the spring are lifted during the previous autumn and stored throughout winter in specially constructed storehouses. After lifting, the trees are graded and tied up into bundles. The bundles are then stacked in the storehouses with their roots outwards. These stacks may be as much as 15 feet high. The roots are loosely covered with wood shavings previously soaked in water. The atmosphere of the storehouse is kept humid and the roots are watered occasionally to prevent them drying out. In such storehouses it is possible to examine thousands of trees of all the recognised commercial varieties. The age of these trees is usually two or three years from grafting.

With such standardised methods of production on so large a scale and with the handling and storage of these trees during winter, it is perhaps not surprising that the nurserymen are fully aware of certain differences in root character between varieties. In fact some go so far as to demonstrate their ability to identify certain varieties by their root as well as their stem characters. Nor is this opinion confined to the nurserymen themselves. Their employees all know which are the varieties that are difficult to dig on account of their great coarse roots, and those that are easy to dig because they are sparse rooters. This in itself is evidence of marked differences in root character due to the scion they are worked to.

Upon examination and comparison of a very large number of trees made as outlined above and grown for two years in the nursery, it was found that the variety of the scion had a marked influence upon the root character of the resulting two year old tree. In fact root character appeared to be determined largely by varietal influence.

This influence was shown in the proportion of coarse to fibrous roots ; the general direction (horizontal or downward) of root growth ; the origin of the main lateral roots on the original root piece ; in anatomy and in the total amount of root produced. The wide differences in root character associated with such varieties as Tetofsky and Winesap (see Figure II.)were found to persist throughout all observed conditions of age, soil and climate. This effect of scion upon root character is not directly correlated with the total amount of shoot growth made by the scion variety. The variety Bechtel Crab makes but a small amount of top growth as compared with most varieties, yet it invariably develops coarse fangy roots (see Figure III.). Bechtel is reputed by the nurserymen to be the coarsest rooted apple tree for its age that they grow. Winesap, on the other hand, had invariably a sparse amount of root, somewhat fine in character and without any big coarse roots such as those of Tetofsky (see Figure II.). There are, of course, a number of varieties the roots of which do not appear to differ much from each other. In this preliminary survey, however, we are not much concerned with these intermediate forms. It appears to be significant enough that, starting with a miscellaneous collection of one year old seedling root pieces, we should end up after two years growth with root systems that are so uniform within a variety, but which differ so markedly between varieties. In view of the miscellaneous seedlings used, the degree of uniformity in root character within a variety and the differences between varieties are most noticeable. The examination leaves no room for doubt. Under the observed conditions there is a marked influence of scion variety upon the root character of the tree when it is one, two or three years old from grafting.

The influence is more clearly appreciated by a comparison of the roots shown in Figures II. and III. with those shown in Figure IV. This latter Figure shows a number of seedlings pulled up out of the nursery row. They are the root pieces upon which the grafts failed to grow. These root pieces have developed shoots and grown into small trees. The miscellaneous character of the seedlings used and the resulting miscellaneous root character of the unworked seedlings is readily observed. This miscellaneous root character among the unworked *seedlings* is in marked contrast with the roots illustrated in Figures II. and III. where it is shown that the two year old trees of commercial *varieties* worked upon seedling roots have a " type " root character. It must be admitted therefore that the scion influence is of no mean order when it can so mould root growth. It is admitted that there is a small range of variation in the root character of trees within a variety. This range, however, is comparatively small. If the range in root

character in the ungrafted seedlings be taken as the standard for comparison then that in the root character of trees within a variety is negligible.

It is usual to regard the variable tree size in the nursery row as the result of a direct influence of the seedling root. It was found, however, that the small trees of a variety had root systems not different in character from those of the larger trees of the same variety. It does not necessarily follow, of course, that such root systems will have entirely lost their individuality because they are moulded into a variety type by scion influence. The fact that they are so moulded, however, calls for a much more searching enquiry into the nature of rootstock and scion influences and into the causes of the somewhat variable growth of young trees that is usually considered to be associated with the use of seedling rootstocks in England. In view of our lack of knowledge of the factors that cause the variations in the size of trees in the nursery row it is impossible to discuss this particular phase of the question further. It is pointed out, however, that the variations may be due to a number of factors some of which are environmental and physiological and are apart from the genetic constitution of the seedling roots. It is obvious that this whole problem must be dealt with before the usefulness of vegetative and seedling rootstocks can be truly evaluated.

The question naturally arises- "Why, under conditions so far investigated, are vegetatively propagated rootstocks apparently so little affected in morphological root character by scion variety whereas root grafted seedlings are so much dominated?"† It is

† Experiments in progress at Long Ashton, under the direction of Professor Barker, show clearly that the scion variety has a pronounced influence upon the *amount* of root produced by trees worked upon some of the vegetatively propagated rootstocks. For example, where Bristol Type V. and Malling Type IX. are used as scions and worked upon Bristol Type V. and Malling Type I. rootstocks, the amount of root formed in the two cases is very different. That formed under the trees worked to Bristol Type V. is much greater in amount than that formed under the trees worked to Malling Type IX. There is, however, no observable change in morphological root character. The roots have retained their morphological character, although the amount of root produced has been profoundly modified. Malling Type IX. rootstock, on the other hand, does not appear to be so easily influenced by the scion variety. The amount of root as compared with trees on their own root is not very materially increased by the use of a very vigorous scion such as Bristol Type V. There is, however, the interesting suggestion that where the vigorous scions worked upon Malling Type IX. have produced scion roots, then the root system of the original stock is strengthened. The strengthening appears largely in the nature of increased diameter of the roots already formed rather than the production of more roots. Thus, it appears that over the period of this experiment, and under its conditions, the vegetatively propagated rootstocks, Malling Types I. and IX., and Bristol Type V., retain their morphological root character but that the amount of root is determined by the scion. Malling Type IX. as a scion has an adverse effect upon root development. On the other hand the vigorous scion Bristol Type V. when used as a scion upon Malling IX. rootstock is not able to materially increase the amount of root produced over that of unworked trees of the same age. (B. T. P. Barker, Journal of the Bath and West Society. 1927, page 235).

thought that an answer has been found in the behaviour of two different groups of trees; namely, in the root character of high budded trees, and in that of double worked trees. Trees of a variety which were budded very low on to the crown of the seedling root were found to have a root character approaching that of the root grafted trees. On the other hand trees that were budded very high on to the seedling stem piece had a very variable root character. These points are shown in Figure V. It appears that if the root proper and the scion variety are separated by a piece of stem other than that of the scion, then the root character may be but little influenced by the top scion variety. In fact this interpolated stem piece appears in many cases not only to materially reduce any influence of scion variety upon root character, but to markedly influence root character itself. Where trees were double worked with certain known varieties the roots of these trees were characteristically that of the intermediate stem piece. This was observed on trees up to two years old from double working. It was also observed that varieties differed in the degree in which a piece of stem, when used as an intermediate piece, was able to influence the root character.

It is suggested that these observations explain in a large measure the results secured by using vegetable rootstocks. Such stocks are stem pieces from which roots have arisen. Thus the scion when worked upon such Paradise rootstocks is always separated from its real root system by a stem piece of varying length. The relative uniformity of top growth secured by the use of such rootstocks may be largely explained by the use of a uniform variety intermediate stem piece. The trees are in fact double worked with a uniform intermediate stem piece. Knight (4) and Grubb (1) working independently of each other, and of the present writer, have shown that a piece of stem six inches long inserted between the scion and to rootstock has a marked influence upon the growth and the behaviour of the scion variety.‡ In view of the evidence set out in this present paper, it is legitimate to argue that a large proportion of the variation that supposedly arises from the use of seedling rootstocks is a direct result of the English custom of working some

‡ It should be pointed out that such variable growth and performance as is recorded for trees upon seedling stocks is most in evidence during the very early life of the tree. In more mature orchards that are free from rogue varieties, the uniformity of tree size and performance is particularly in evidence. In other words trees upon seedling stocks approach uniformity more and more as they reach maturity. This uniformity of mature trees of a variety upon a given soil was clearly brought out by the recent fruit soil survey, carried out by Messrs. Wallace, Spinks and Ball of the Research Station, Long Ashton, Bristol. The importance of this ultimate tree size and uniformity as against a supposed lack of it in the early years of the tree's life must be considered in any discussion of the relative merits of seedling and vegetatively propagated rootstocks.

6-8 inches high upon the seedling stem. This leaves some 8-10 inches of seedling stem between the scion and the root. The trees therefore, have present between the scion and the root system a piece of the stem of the original seedling. Because of the variable nature of miscellaneous seedlings these stem pieces are very different The trees, because of this interposed stem piece, have the same make up as double worked trees. Trees worked upon vegetatively propagated rootstocks also have a stem piece of varying length between the scion and the root system, the stem of the stock. In the case of trees worked upon the stems of seedlings, the interpolated stem piece varies in character from tree to tree, but with trees upon uniform vegetative stocks this interpolated stem piece is of a uniform character. Emphasis is laid upon this fundamental difference between the two sets of trees. A discussion of this emphasis, involving as it does the very nature of rootstock influence, must be left to a future occasion. If,—as has been shown by the work of Knight(4) and of Grubb(1) and which is indicated in the observations upon high budded trees recorded in this paper,—the intermediate or interpolated stem piece can exert such a marked influence upon the growth of the scion variety, particularly during the early life of the tree, then it is but reasonable to suppose that it may also have a modifying influence upon root growth. The length of time over which such infleunces may be observed is still a matter which cannot be decided. At the present time it is premature to attempt an extended discussion of these interesting points or make any further reference to them except to point out that a greater degree of uniformity in trees is secured during early years by using seedlings of certain species of crab apples than by using the so called free stocks. The uniformity of type and character in the former is in marked contrast to the lack of it in the latter stocks.

While recent investigations have focussed attention upon the differences in behaviour between trees upon seedling and upon some vegetatively propagated rootstocks, the question of the relative economic importance and value of seedling as against vegetative stocks still remains to be settled. The problems of the relation of seedling rootstocks to the growth of scion have scarcely been touched upon as yet in an experimental fashion. It is at least suggestive that vegetative rootstocks are so little used on the American continent which is the largest apple producing section in the world. It was found in the larger commercial orchards in the Middle West, particularly the younger ones, that there was a remarkable degree of uniformity of tree size and vigour. The older orchards, it is true, presented a rather patchy appearance, particularly in the parts

FIG. I.

A section of One Year Old Seedlings used for Bench-grafting in U.S.A.—A. grown from imported French crab apple seeds. B. coarse rooted seedlings selected from A. C. unbranched seedlings selected from A. D. grown from Vermont crab apple seeds. E. seedlings of a Tennessee species crab apple. F. seedlings grown in Washington State.

FIG. II.

One Year Old Grafts of Bench-grafted Seedlings.

A. Whitney Crab.
B. Grimes Golden.
C. Winesap.
D. Tetofsky.

FIG. III.

Two Year Old Trees of, A. Rambo. B. Bechtel. C. Jonathan, Bench-grafted upon Seedling Roots.—Note that the amounts of top growth and root growth are not necessarily directly proportional.

FIG. IV.

A Group of Unworked Seedlings.—These were the root pieces upon which the grafts failed to grow. Such seedlings show a wide range of root character. This is in marked contrast to the uniformity of root character in those cases where the grafts grew.

FIG. V.

where the winters are very severe. In the more amenable climates the varieties are remarkably uniform. The differences between varieties, however, were most marked. The writer saw orchards of varying ages under various conditions. While variation was present, yet when due allowance was made for the extreme severity of the climate, soil and culture, the amount of variation was remarkably small. In fact under reasonable conditions of soil and culture the uniformity of tree size within a variety was more pronounced than was the lack of it. A case in point was a six year old orchard where over 900 out of 1,000 Wealthy trees came into bearing in the fifth year from planting, and with a remarkably uniform crop from tree to tree. The remainder were promising very well for a good show of blossom buds the following spring. In any case, the aim of the orchard cultivator is to obtain the best possible crop of fruit as regularly as possible. It is possible that this may be achieved by the use of vegetatively propagated rootstocks. It is clear, however, that the range and usefulness of seedling rootstocks has not yet been fully investigated, and the time has not yet arrived for deciding in favour of either class of stock. It is probable that there are certain conditions which render either one preferable to the other.

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SOME OBSERVATIONS ON RINGING FRUIT TREES TO INCREASE PRODUCTION.

By Thomas Swarbrick.

Ringing as a method of causing increased fruit production is an old-established custom. It has, in fact, been known and practised in the vine lands of Europe for many centuries. Its widespread use in the vine industry is at least indicative of its practical value under certain conditions. Its recent adoption on a fairly wide scale in fruit growing generally has led to a need for fuller information upon its possibilities and limitations.

Ringing consists in the removal of a complete band of bark tissue from around a stem or branch. The ring may be of any width from the thickness of a knife-edge upwards. In the former case it is known as knife edge ringing or scoring. A similar or partial effect upon the growth and fruit bud formation may also be produced by binding a strand of wire very tightly round a branch, but the general experience is that owing to the difficulty of getting such wire tightly bound, the results are not shown until the second year after the operation. Because of this somewhat less vigorous response obtained by the use of a wire band it may be adopted under conditions where the removal of a ring of bark would be too drastic. A ringing effect, in whole or in part, may be produced naturally by canker or by animals eating away the bark. The heavy blossoming of a badly cankered tree is largely the result of the partial ringing effects of the disease.

In practice, ringing is confined to the perennial woody plants, *e.g.* vines and fruit trees. It is well known that if incorrectly carried out ringing may cause the death of a tree or a branch. The use of ringing in horticulture, however, has as its object the bringing of unproductive over-vegetative trees into a condition of fruitfulness. Seeing that death is so easily produced by ringing, it has obvious limitations and dangers, and should only be practised by those who by study or experience have grasped the principles involved. In the hands of such, ringing has considerable economic application and value, particularly where climatic or soil conditions give a relatively vigorous and excessive amount of extension growth. Its usefulness is almost entirely restricted to the vigorous over-vegetative trees, which by reason of their excessive growth do not

form flower buds in sufficient quantity to give an economic crop of fruit. As a method of causing early bearing in " filler " trees of the larger commercial plantations, it has a considerable application. As the useful length of life of these " filler " trees is distinctly limited, any practice that will cause them to yield early crops of fruit is to be welcomed. It is doubtful whether the permanent trees of a plantation should be ringed until they are long past the age at which they are due normally to come into bearing, but when properly carried out there appears to be little or no danger in the practice. Gourley and Howlett in America have recently reported the ringing of 12,000 apple trees " without the loss of a ringed limb or apparently injured a tree permanently."

Where a strip of bark is removed from a stem or branch it leaves the woody cylinder exposed. While, theoretically, it should be possible to remove such a ring of bark at any time during the year, yet in practice it is most difficult to do this except during the growing season. This is when the bark " slips." This slipping of the bark is an indication that certain growth activities are taking place in the stem. Situated between the bark and the wood is a complete sheet of small living cells known as the cambium. It is due to the growth and division of these cambial cells that the tree increases in girth. When the bark begins to slip in spring it is an indication that the growth and division of the cambial cells are about to begin again after a period of winter dormancy. The cambium, then, is a most important tissue in woody plants and there will be occasion to refer to it again a little later.

When ringing, it is easy to tell by the resistance offered to the knife when the bark has been cut through and the wood reached. Experiment and experience have shown that care should be taken to cut the wood as little as possible, because the wood is the channel for the conduction of the water from the roots to the leaves. If cut too deeply this channel is of course very much reduced and the parts above the ring may suffer from an acute water shortage. This is shown by the wilting of the leaves. The removal of the ring of bark carries away the cambium and leaves the woody cylinder exposed. It is easy to see, therefore, why death results unless the rings heal over. The effects of ringing, whether they are ultimately beneficial or harmful, follow as a direct result of the temporary or permanent removal of the ring of cambium and bark. The primary object of ringing is to induce the formation of flower buds. Obviously then it is essential that there should not be too much check upon growth, and it follows that the rings should be induced to heal over soon after they are made.

In order to obtain more definite knowledge upon this matter, a series of experiments was carried out at Long Ashton during 1925-26. Branches of young vigorous ten-year-old apple trees were ringed at monthly intervals from February to September 1925. The rings were treated in various ways, some being covered over with adhesive tape, others being left bare. The rings were made as carefully as reasonable commercial practice permits. The width of these rings was about $\frac{1}{4}$-$\frac{1}{2}$ inch. Knife-edge rings were also made by running the knife round the branch, pressing firmly the while so that the cutting edge was always well in contact with the wood. At suitable intervals after ringing, branches were taken into the laboratory for examination. Field notes were also kept, and from these and the laboratory observations it is possible to make the following generalisations.

If the tree is to survive ringing, then the rings must heal over. In this healing over it is essential that the continuity of the cambium and bark be re-established. It was found in these experiments that in a large number of cases where the wounds were not covered over with adhesive tape, although the rings were completely covered over with callus, no healing had occurred. In such cases the real bridging of the gap did not take place until the following spring. This condition is illustrated by Figures 1 and 2. Figure 1 shows a ring covered with callus but not healed in the true sense. Figure 2 shows a knife edge ring which has healed over completely. The evidence suggests that the best results are obtained when the rings heal over during the year in which they are made. In these experiments this was most easily obtained by making the rings during the latter part of May and covering them over with adhesive tape directly they are made. This covering hastened and increased callus formation from the edges of the bark and cambium tissues. The width of the ring largely determines how quickly it will heal over. Narrow rings heal more quickly than do wide ones. As a practical rule it is best to make the rings just as wide as the thickness of the bark will permit of easy handling of the operation. By this rule the older the branch the wider will be the ring. Should the rings have been made rather wide, or be sluggish in healing due to weather conditions, the healing may be hastened very materially by paring the edges of the callus already formed and covering over at once with adhesive tape. Grafting wax carefully applied would serve the same purpose but not so well as adhesive tape. Where adhesive tape is not procurable, the simplest procedure is to take strips of calico, bind them over the ring and tie them above and below the wound so that the ring is completely covered over. The outside of the calico is then coated with vaseline or some other

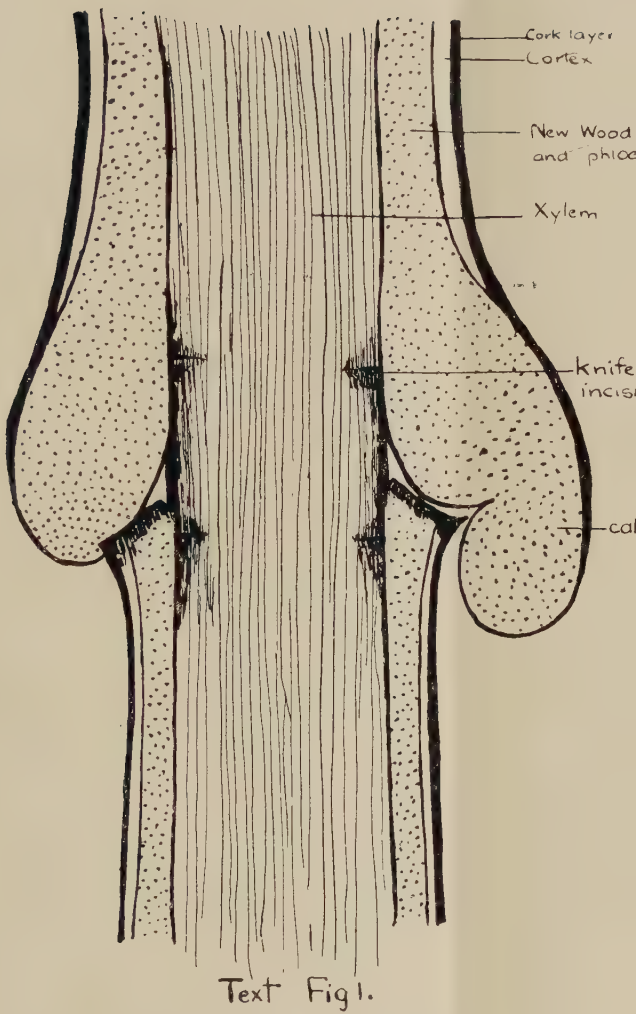
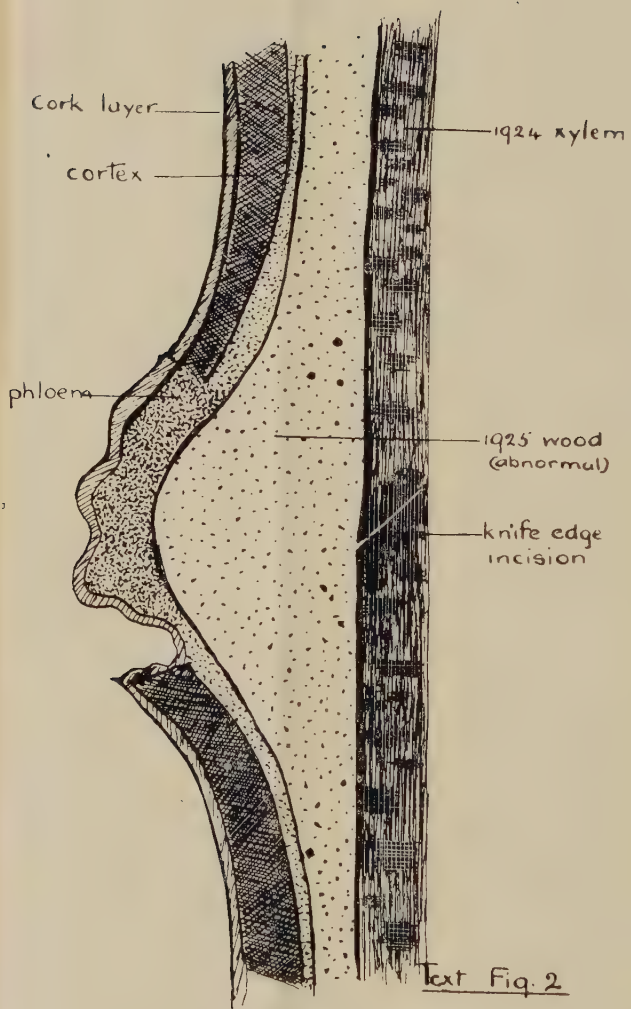


Fig. 1. Diagramatic representation of a ring which is cove

Fig. 2. Diagramatic representation of a knife edge ring s
made in the case of Fig. 1 would have healed in



with callus, but not healed in the true sense.

ing the wound completely healed over. A narrower ring
same way as in the case of Fig. 2.

substance, which will render it impervious to air and water. The objection to grafting wax applied directly to the ring is that it fills up the ring and prevents the callus from joining over the woody cylinder. Care must be taken to cut the strings binding the calico after healing has taken place. The object in covering up the rings is to prevent the rapid loss of water and the consequent drying out of the tissues.

The effect of ringing upon the production of flower buds depends entirely upon the time at which it is carried out. It has been long known to practical men that ringing, to be effective, should be carried out in the early part of the summer. The above experiments carried out at Long Ashton have shown that during spring the food reserves of the stem—which are mostly starch—are used up in the production of the first flush of spring growth. Food reserves begin to accumulate again in late June and early July. Ringing usually causes a considerable reduction in the amount of growth that a tree makes above the ring and when carried out in spring or early summer also results in an abnormal accumulation of starch above the rings. Ringing in spring also causes the starch accumulation to begin at least a fortnight earlier than in normal unringed branches. Both these factors, starch accumulation and the slowing down of elongation growth, appear to be associated with flower bud formation in apples. The effectiveness of root pruning in bringing strongly vegetative trees into fruiting leads us to suspect that the slowing down of growth is the more important single item in such cases. Ringing, to be effective in inducing flower bud formation, must be done early enough so as to slow down elongation growth and initiate a starch accumulation in the parts above the rings well in advance of the time of normal bud formation. At Long Ashton, the most favourable date for ringing was found to be from the middle to the end of May. The date most suitable for ringing in other districts will be best determined by the persons concerned, but is not likely to vary much from the above. Ringing when carried out much later in the season has little or no influence upon the number of flower buds formed during the current season, but may have an effect in the succeeding one. It has invariably proved disastrous to ring before the bark slips. Ringing in February or March was almost always followed by the death of the part above the ring due to the failure of the rings to heal over. The branches ringed before bud-break subsequently broke off at the point of ringing. It is only safe to ring when the bark slips in spring and early summer. Furthermore, the ringing of stone fruit trees is not recommended. It has almost invariably proved fatal to the tree, due no doubt to the excessive gumming which follows wound-

ing and the extreme readiness with which these trees are attacked by wound parasitic fungi.

Knife edge ringing gave very variable results. There are grounds for thinking that while the removal of a complete ring of bark is disastrous if done in February, knife edge ringing gives its best results if done then. This is also true of binding the branches with a wire band. In any case knife edge ringing cannot be relied upon to produce a consistent result. This seems to be associated with the very rapid healing of the wounds. When knife edge rings were made during the growing season, the cambium and bark were often healed over in ten days. Because of this knife, edge rings may not give any marked starch accumulations or any consistent result as regards flower bud formation.

Ringing also has an effect other than the inducement of flower buds *above* the rings. Extensive shoots almost invariably develop immediately *below* the rings. This latter response has considerable practical importance in the culture of certain varieties, and in regions where fruit trees develop excessive amounts of "bare wood." By making knife edge rings above the individual buds of the bare wood region, the buds are induced to develop into leafy shoots. Thus the response below a ring is very localised. Branches developed in this way may be induced to form blossom buds in due course by suitably ringing the main scaffold branches.

Occasionally trees are partially or completely ringed by such accidents as rabbits or other animals finding an entrance into a young orchard during winter. Occasionally also trees which have been ringed do not callus properly and show signs of weakness and even impending death. In such cases, if the trees are still worth saving recourse may be had to bridge grafting. Very large trees may be saved in this way. This operation should be carried out in spring at the time of ordinary grafting. Bridge grafting, however, has been practised during summer with success where due precaution was taken to prevent the drying out of the grafts and unions.

Practical Conclusions and Suggestions.

From the physiological point of view, there is no serious objection to ringing provided that the trees are vigorous and that the ringing is carefully carried out at the right time of the year. This will be some time in May or very early June. The rings should never be more than about half an inch wide, the width depending upon the vigour and size of the trees or branches. Should healing be

slow precautionary measures should be taken. It will usually suffice to pare the callus already formed and then cover up with some substance that will keep down evaporation. Grease banding would serve if adhesive tape is not available. Ringing before the beginning of May is not recommended, and ringing after the middle of June does not give any increase of blossom bud formation in the current season. Except for "filler" trees which may be ringed on the main trunk, it is probably the best practise to ring a proportion of the main branches each year. Stone fruit trees, such as plums and cherries, should not be ringed.

In conclusion, if should be stressed that ringing is but a temporary measure, and in this sense has but limited application. It undoubtedly has a wide application for use in bringing "filler" trees into bearing. In the case of permanent trees, ringing should not be practised unless sound cultural methods have failed to put the trees on a more permanent basis of fruiting capacity. This practice will be governed by the principle that in the case of over-vegetative trees any practice that will slow down growth will be conducive to flower bud formation. Suitable ringing will result in increased flower bud formation. The factors controlling the set of apple blossoms are quite different from those governing their formation. Where there is a regular show of blossom but no set of fruit, it is not advisable to ring the trees. Before attempting ringing on a large scale it is advisable either to carry out a preliminary trial on a small scale or to obtain advice from the nearest Horticultural Research Station, or the County Horticultural Officer.

INVESTIGATIONS ON GOOSEBERRY AND RED CURRANT VARIETIES.

Progress Report.

By J. G. Maynard.

Gooseberries.

In 1925 it was decided to undertake a detailed study of varieties of gooseberries as a preliminary to the development of certain lines of research on this fruit. Accordingly, during the following winter, 43 varieties were selected for examination and small numbers of bushes of those kinds were purchased, under name in each case, from representative commercial sources in the south-east, south-west, midlands and eastern counties. The varieties selected in the first instance are almost all more or less well known and possess potential commercial value.

It was observed in the first growing season, and noted in more detail in the second year, that the individual varieties as collected were extremely mixed even in comparatively small samples, and contained large numbers of rogues.

Thus in the case of those collected under the name of Leveller, six different sorts occured. The stocks of plants came from four distinct sources and only one set contained nothing but true Leveller.

Only Lancashire Lad, Early Sulphur, May Duke, Leader and Langley Beauty were obtained definitely true from all sources. Although only 43 varieties were ordered by name, about 70 different kinds are actually to be found in the collection as received.

In addition to the mixture of varieties, there is evidently some uncertainty as to nomenclature. This is perhaps not surprising when one considers the very large number of varieties introduced into commerce at one time and another, notably as a result of the Lancashire gooseberry competitions.

Variation and uncertainty in nomenclature are not only most inconvenient and confusing in themselves, and bring about the usual difficulties for the grower, but in the special case of the gooseberry they may lead to serious complications in connection with

spraying practice. For instance, it is often stated that the variety Golden Drop is particularly subject to lime sulphur injury, but it appears that the variety referred to is actually Yellow Rough, which is probably the same as Early Sulphur. The distinction between the two former varieties is quite definite, the fruit of the true Golden Drop being downy, and that of the other very hairy. The true Golden Drop is of little merit and rarely grown.

In view of the obvious necessity, shown by this original collection, of taking steps to sort out individual varieties and obtaining pure lines of each, clone races are being established for future propagation prior to carrying out pruning, cropping and other trials. In addition, lime sulphur spraying is being carried out on individuals of each variety to ascertain the degree of susceptibility to spray damage.

Red Currants.

An analagous study to that on gooseberry varieties is also in progress on red currants. Observations made in the plantations at Long Ashton in the spring of 1925, indicated that several named varieties collected from various sources, included many rogues. Subsequent observation on farms showed that a mixture in this fruit is extremely common.

Clone races of every variety that could be distinguished at Long Ashton have consequently been started, and other distinct varieties found elsewhere are being added to the collection by degrees.* It is proposed, when this pure-line material has been propagated in sufficient numbers, to lay out pruning, cropping, and other trials, but these may need to be delayed for a period pending further investigation of certain red currant diseases for which satisfactory control measures must be found before such trials can be accurately carried out.

In the latter connection it may be noted that the variety Raby Castle, which is very largely grown in the Bristol Province is cropping poorly, wherever the writer has examined it, a result probably due to a specific disease. This behaviour has also recently been noted by Massee.(1)

REFERENCE.

(1) Massee, A. M.—"The Life History of the Black Currant Gall Mite, *Eriophyes ribis* (Westw.) Nal." Bulletin of Entomological Research, Vol. XVIII., Pt. 3, Feb., 1928, pps. 296-239.

* The Station is indebted to the Ohio Agricultural Experiment Station for a collection of varieties.

STRAWBERRY INVESTIGATIONS.

(Progress Report).

The series of investigations on strawberries at present in progress at this Station date back from 1921, when reports were received from some of the more important strawberry growing districts in the South of England, on the serious nature of the so-called " Red Plant " disease of strawberries.

Since that time strawberry investigations have formed a very prominent section of the work of the Institute and this has been especially so during the seasons 1925 to 1927.

From the earlier work, it soon became evident that the problems involved in connection with the causes of strawberry failures were both numerous and complex and that their solution called for a very extensive programme of investigations.

A large and comprehensive programme of work was accordingly drawn up which, while relating mainly to the pathological aspects of the more important " abnormal " forms of plants occurring in cases of failures, also included studies in connection with pomological features, physiology and nutrition. More recently, also, it has been considered desirable to extend the programme of the strawberry breeding work to include in it the breeding of new varieties for certain specific purposes.

During the course of the work, a number of papers have been written by members of the staff responsible for the various aspects of the work, in which the more important findings which have emerged from the investigations have been recorded. A list of these is appended.

Reference to these published reports will indicate the scope of the programme and the amount of progress made since the initiation of the work. It will be seen that it was necessary, at the outset, to carry out an elaborate series of investigations on the growth cycle of the normal strawberry plant in order to provide a sound basis from which to view the numerous problems which presented themselves relating to the " abnormal " forms of plants requiring consideration.

Various points relating to cultural practices and the effects of these on the plant were investigated, the more important points

which were examined being times and methods of planting, methods of taking runners, the relation between vigour of parent and progeny, " strains," " rogues," crown damage, root damage, waterlogging, etc.

It has been shown that many of these points are of great importance in considering the present problems of the strawberry grower and that some of them require special consideration in the study of certain of the prevalent " abnormal " forms of plants.

In the investigations dealing directly with questions of strawberry pathology, attention was focussed in the first stages on the types of plants known as " Red Plant," " Cauliflower," " Patch " and " Small Leaf." The possibility of these forms being different phases of a common trouble was studied and experiments were carried out to determine whether the eelworm *Aphelenchus fragariae* was the organism responsible in producing these types. While these investigations were in progress attention was also given to the problem of the control of " Red Plant." The possibility of the transmission of the " disease " from the parent through the runner was studied with the object of ascertaining whether a suitable measure of control could be obtained by applying " roguing" methods in propagation beds. The evidence obtained showed that there was a very strong possibility of " Red Plant " being substantially controlled by such methods.

During the course of examining the more prevalent forms of " abnormal " plants, it became evident that one form of " Small Leaf " was associated with infestations of the aphis *Capitophorus fragariae*, and infection experiments were accordingly carried out on healthy plants with this aphis. It was found that the particular form previously observed resulted from the infections, and it appeared that the form could be attributed to attacks of this pest. Since then the relation between this type of plant and infestations of the aphis have been widely studied in the field in all the larger strawberry growing areas of the country and it has become evident that the pest is causing very widespread damage.

As knowledge of abnormal forms has accumulated it has become necessary to attempt to describe the distinguishing features of the various forms and to record the possible order of relationships between some of them, together with the various methods by which they may be produced, the conditions under which they most frequently occur and the organisms considered most likely, on the evidence available, to be responsible for their production. The grouping is tentative but, since it serves to summarise the present state of knowledge on the various abnormal forms, the details are listed and discussed in a later section.

Results from the work on the nutrition of the strawberry plant will only emerge very slowly in view of the present position with regard to the various abnormal forms and the very nature of the problems involved. The strawberry crop is greatly influenced by climatic conditions and, for this reason alone, it is not safe to draw conclusions from manurial experiments on strawberry plants unless the experiments are carried out over a fairly large number of seasons.

The grower's problem of manuring his crop is also a very special one in that in some districts it is not possible, in the majority of cases, to grow the crop in a rotation which allows of a number of years between successive plantings of it. The grower, too, is often not a general farmer and having no considerable head of stock, must rely solely or largely on fertilisers to feed his plants. Thus his problems can only be properly appreciated by following the effects of various manurial treatments over several successive plantings on the same piece of land. This is the method which has been adopted at Long Ashton and hence no attempt will be made to draw final conclusions for many years, though the results will be recorded periodically in progress reports.

Investigations in Progress.

(*a*) *Pomological.*

Strain Trials.—As mentioned in a previous report, trials of strains of Royal Sovereign, obtained from representative growers at Cheddar, are being carried out. These strains were first planted at Long Ashton in 1923. Since that date a limited number of runners have been planted annually from maidens of each strain. Thus each strain is being maintained over a number of years. The first and second generations of these strains have each borne three crops, the third generation two and the fourth one crop. For various reasons such as variation in time of planting from year to year, variation in site and soil texture of the location of each generation and annual variation in weather conditions it is probably best to express the comparative results of cropping by showing the maximum crop produced in one season by each generation of every strain as 100, the crop from the remaining strains being shown in proportion.

TABLE I.

Strain No.	1st Generation			2nd Generation			3rd Generation		4th Generation
	1924	1925	1926	1925	1926	1927	1926	1927	1927
1	60.75	61.75	39.25	100	60	42	43.25	100	100
2	76.5	100	100	91.5	100	100	100	97.25	80
3	68	84.25	67.5	66.5	68.9	59	62.75	77.25	80
4	50.25	71	60	65.9	70	44	69	59.75	80
5	76	69	62.5	57.5	76	72	91.75	66.25	67
6	100	80	35.5	28.5	44.5	23.3	53	53.75	54
7				32.5	57	24.5	61.75	50	50

The most striking feature of this table is perhaps the consistently good performance of strain 2 throughout. It is understood that this strain has been selected constantly, over a period of many years, by the grower who employs the utmost care in the selection of his plants and runners.

At first sight the remaining strains are striking mainly on account of their apparent inconsistency. On close examination, however, a few, at least, of these inconsistencies seem explicable. For instance, referring to Table I., in strain 1, the crop in 1924 was poor. It is reasonable to suppose that because of this the runners were at least better than had the crop been very heavy ; and this is borne out by the fact that these runners, planted in the autumn of 1924, cropped well in 1925. To carry this a step further, runners taken after this heavy crop in 1925 fruited poorly in 1926 and, again, runners taken after this poor crop fruited well in 1927. With strain 6, which cropped so well in its first year, it is notable that runners taken after this heavy crop did badly.

No attempt was made prior to 1926 to select runners from particular parents within each strain. Table II. indicates the order of merit in cropping of several strains together with figures showing the incidence of " Red Plants," the strain containing the *smallest* number of " Red Plants " being indicated in each case by the numeral 1, etc. Figures are not available for strain 1, so this has been omitted. It will be seen that the order of merit both in cropping and in " Red Plant " infection is fairly close indicating, as would be expected, that the proportion of " Red Plant " in a strain bears very definitely on the cropping of that strain.

TABLE II.

Strain No.	1st Generation 1926		2nd Generation 1926		3rd Generation 1926		4th Generation 1927	
	Crop O.M.	Red P. O.M.	Crop O.M.	Red P. O.M.	Crop O.M.	Red P. O.M.	Crop O.M.	Red P. O.M.
2	1	1	1	1	1	2	1	1
3	3	4	4	5	4	5	1	5
4	1	2	3	2	3	1	1	1
5	4	3	2	3	2	3	4	3
6	5	5	6	6	6	6	5	6
7	—	—	5	4	5	4	6	4

An attempt is now being made to eliminate " Red Plant " completely from all these strains and an examination of their relative cropping capacity will be made, using only completely healthy plants if possible.

Further work is in hand on strains and strain selection, plants having been obtained from various sources for the purpose. Information is being collected as to their relative merits, but until various pathological troubles have been overcome, progress will necessarily be very slow.

Varieties.—A grouping of varieties according to their botanical characters has been commenced. The variety collection at the Station is moderately large and will be increased as required, but here again pathological troubles make it futile at the present stage to carry out anything in the nature of cropping trials. However, records are being kept of the relative susceptibility of varieties to various diseasès.

Among less well known varieties which have been under observation for the past two seasons, Tardive de Leopold stands out at present for its vigour and apparent resistance to disease. It is a late variety, bearing a heavy crop of large fruit, which appears to be of somewhat better quality than Madame Kooi. It has, however, one important difference from most varieties grown in this country in that very few of the flowers bear stamens, and for this reason a late flowering variety should be planted with it for purposes of pollination.

Clones.—The initial work on clones was commenced in 1925, in connection with investigations relating to strains, and the normal development of the strawberry plant referred to in other sections of this report. Since then it has been extended to certain aspects of the pathological problems under examination.

The progenies of individual strong and weak parents and of individual healthy and diseased parents are under observation. Results show that " Red Plant " crowns produce " Red Plant " runners. Some plants may have only one " Red Plant " crown, and it is believed that runners formed from healthy crowns on such plants may remain healthy. Runners from aphis infested plants are generally aphis infested, as is mentioned in more detail elsewhere in this report. The variations, if any, in transmission of vigour from parent to runner are difficult to trace due to the prevalence of pathological troubles.

(*b*) *Breeding Investigations.*

During the course of the investigations on the pathology of the strawberry, it has been noted that the four varieties Aberdeen Standard, Dumbarton Castle, Sturton Cross and Tardive de Leopold appear to show marked resistance to attacks of the aphis, *Capitophorus fragariae.* In view of this, these varieties have been used as

parents, selfed—in the first three cases—and in crosses with the susceptible varieties, Royal Sovereign and Stirling Castle, in an attempt to obtain new resistant varieties with commercial qualities equal to those of the latter two varieties.

(*c*) *Manurial Experiments.*

There are two manurial experiments in progress. It is proposed to continue both of these over several successive plantings, the plots to be replanted at intervals of three years. The variety used in each experiment is Royal Sovereign.

The older of the two series was planted on the first occasion in April, 1924, and for the second time in July, 1926, so that there are available records for one complete cycle.

There are eight differential manurial treatments given, each treatment being in triplicate, and each plot is one-sixtieth of an acre in extent. The plants are planted out in rows 30 inches apart with the plants spaced at intervals of 18 inches in the rows.

The object of the experiment is to compare various systems of manuring with organic and inorganic fertilisers with systems involving the use of dung. The effect of omitting potash from the fertiliser where dung is not given is also under test. In all cases where nitrogen, phosphorus and potassium are given in different manures, the amounts of these elements are comparable. Where dung is applied an attempt has been made to apply this at a rate calculated to supply readily available nitrogen at rates similar to those given in the fertilisers. For the present the rates of manures applied are designedly low as it is proposed to raise these as is found desirable in the later plantings.

The details of the manurial treatments are as follows :—

Treatment.

A. Dung at 20 tons per acre, ploughed in previous to planting to serve over three year period.

B. Dung at 10 tons per acre, ploughed in previous to planting.
Annual Spring Dressing :—
Sulphate of Ammonia to supply 20 lbs. nitrogen per acre.
Superphosphate „ „ 150 „ total phosphate per acre.
Sulphate of potash „ „ 50 „ K_2O per acre.

C. Shoddy at 2 tons per acre (5% nitrogen basis) ploughed in previous to planting.
Annual Spring Dressing :—
Steamed Bone Flour to supply 150 lbs. total phosphate per acre.
Sulphate of Potash „ „ 50 „ K_2O per acre

D. Complete Manure (non-bulky but nitrogen and phosphorus in organic form).
Annual Spring Dressing :—
Hoof and Horn *or* Dried Blood to supply 40 lbs. N. per acre.
Steamed Bone Flour „ „ 150 „ total phosphate per acre.
Sulphate of Potash „ „ „ K_2O per acre.

E. Complete Manure—Inorganic Materials.
Annual Spring Dressing :—
Sulphate of Ammonia to supply 40 lbs. N. per acre.
Superphosphate „ „ 150 „ total phosphate per acre.
Sulphate of Potash „ „ 50 „ K_2O per acre.

F. " Organic " Manure containing nitrogen and phosphorus. (No potassium given).
Annual Spring Dressing :—
Hoof and Horn *or* Dried Blood } as D.
Steamed Bone Flour }

G. Dung at rate of 12 tons per acre ploughed in previous to planting.
Dung at 8 tons per acre in spring following first crop—material allowed to rot on surface.

H. Control, no manure.

The data obtained relate to growth characters, incidence of disease, mortality, and cropping—total crop, marketable crop and quality of berries are recorded.

For the first planting, four " strains " of Royal Sovereign were obtained from commercial growers to test the necessity or otherwise of building up a stock from a common source for this work. The strains showed great differences in behaviour both as regards growth characters and cropping.

The results for cropping show that the three dung treatments given—A, B, G—produced much higher yields than the various treatments with the organic and inorganic fertilisers.

In view of the significant differences found between strains in this experiment and in the second series described below, a stock of a single " strain " is being used in all future plantings.

The younger series of plots has been commenced with a view to investigating in detail the effects of deficiencies of nitrogen, phosphorus and potassium. There are six manurial treatments given and the treatments are in triplicate. Each plot is one-sixtieth of an acre in extent. The first planting was carried out in September, 1924, when five strains were used, and the second planting was made in August, 1927, using plants of a single " strain." The records taken are similar to those in the other series.

As in the case of the previous experiment, the rates of manures applied are designedly low, but the rates on the fertiliser plots are to be raised for the second planting.

In the initial scheme the dressings were as follows :—

Treatment.

O. Dung at 20 tons per acre, ploughed in previous to planting to serve over three year period.

K. Complete Manure—Annual Spring Dressing :—
Nitrate of Soda to supply 40 lbs. N. per acre.
Superphosphate „ „ 100 „ total phosphate per acre.
Sulphate of Potash „ 50 „ K_2O per acre.

L. As K. but omit nitrate of soda.
M. As K. but omit superphosphate.
N. As K. but omit sulphate of potash.
J. Control—no manure.

The growth and cropping records over the first planting again showed marked differences for the various strains and also showed that variations in growth are likely to occur due to soil variations as growth and cropping on a strip of land running across the plots have differed markedly from the remainder of the area irrespective of differential manurial treatments.

The cropping records in this series also show higher yields from the dung treatment than from the complete fertiliser treatment. No significant results have been obtained to date from the various omissions.

(*d*) *Pathology.*

Abnormal Forms of Strawberry Plants.—In pursuing field investigations on the various forms of abnormal plants which occur, the problems have been rendered exceedingly complex owing to the fact that frequently one plant shows characteristic symptoms of more than one trouble. This fact seemed likely to lead to confusion of ideas and, in view of this, it was considered desirable for the various workers concerned to agree upon a provisional grouping of the more important abnormal forms.

The details of the grouping are as follows :—

Types of Abnormal Forms.*

Type I. "Damaged Crown."†
Crowns weak, numerous and spaced. Petioles long and thin, red in some varieties. Flowers absent. Root development normal.
Cause—Crown damage.

Type II. "Small Leaf."
Crowns weak, numerous and dense. General colour of plant yellowish green. Petioles short and thickened. Flowers weak. Root development normal but of poor vigour.
Causes—Waterlogging, dessication and cultivation damage.

Type III. "Cauliflower."
Crowns hypertrophied or extremely fasciated. Leaves much reduced and deformed. General colour of plant yellowish green. Petioles short and tapered, and varying in colour from beetroot red to pale blue green. Flower absent or resembling a cauliflower. Root development normal in form but poor in vigour.
Cause— *Aphelenchus* ?

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* The above list of types is a shortened version of the table which is given in the article in the Journal of the Ministry of Agriculture (17) and which, after completion, was fully discussed with and agreed upon by the Advisory Officers from the Southampton, Tamar Valley and Clyde strawberry growing districts.

† This form has been frequently referred to by growers as "Miffy."

TYPE IV. "RED PLANT."
Crowns few and spaced. Leaves reduced and deformed and in some varieties red in colour. Petioles tapered and beetroot red in colour. Flower reduced or dead and not outwardly visible. Root development normal.
Cause— Aphelenchus ?

TYPE V. "APHIS" PLANT.
Crowns weak, numerous and dense. General colour of plant yellowish green. Leaves crinkled and cupped to normal. Petioles short and thickened. Flowers numerous and weak or absent. Root development, normal in character, but poor in vigour.
Cause—Capitophorus fragariae.

TYPE VI. "PATCH."
Characters are either as for Type II., Type V. or show features of both with the exception that the number of roots produced is poor instead of normal and that dead crowns are present.
Causes— As II or V.

TYPE VII. SUDDEN WILT.
The plant wilts rapidly, usually about the time when the fruit is almost fully formed. It either dries subsequently or becomes a "Small Leaf" type (Type II). Cases of this type have been relatively few in number and have occurred almost entirely in notably wet seasons such as 1924.
Causes—As II; also root feeding insects such as *Melolonthid* and *Curculionid* larvae.

It will be seen from the list that seven types are distinguished in the present grouping, but it should be mentioned that it appears probable that the number will be reduced to four or five in the future.

It has been shown that Type I. results when the crown of the plant is injured at certain seasons of the year. Type II. is produced when the roots of the plant are injured either by careless cultivation or by dessication or waterlogging. Types III. and IV. are the well known "Cauliflower" and "Red Plant" forms and it seems possible that they represent different stages of the same disease. The evidence as to whether these forms result from attacks of the eelworm *Aphelenchus fragariae* is at present inconclusive. Type V. has been produced experimentally by infection with the strawberry aphis *Capitophorus fragariae* and all the evidence obtained to date indicates that this pest is the causal organism. Type VI. is the form widely known among growers as "Patch Plant" and it appears almost certain that it represents a more advanced form of Types II. or V. or of both, though there is evidence in some cases that the development of the form is associated with soil factors. The last type has been provisionally given the name of "Sudden Wilt," an expression which is descriptive of the sudden collapse and drying out of the plant which occurs. Little opportunity has been afforded of studying this type in detail to date, since the season of 1924 was the only occasion on which it occurred to an appreciable extent, which suggests that the form may be associated with especially wet conditions.

A Survey of Strawberry Troubles.

During the summer of 1927, the strawberry districts of Cheddar, Tamar Valley, Worcester, Hereford, Cheshire, Denbigh, Wisbech, Southampton and Kent were visited with the object of determining the distribution of the more serious strawberry troubles in these important areas. The observations were not confined to the occurrence of diseased forms, special attention being also given to various features of the practices in the areas such as propagation methods, methods of planting, cultural points, etc., and the possible relation of certain of these to the incidence of abnormal growth characters.

The data accumulated during the course of this survey will be reported and discussed in a separate paper at a later date.

"Red Plant" and "Cauliflower" Diseases.

The physiological anatomy of plants showing the characters of "Red Plant" and "Cauliflower" diseases is under investigation. In this work, the features shown by the "diseased" plants are compared with those exhibited by plants showing normal characters. Particular attention has been given to plants showing the first stages of the diseases and, concurrently with the anatomical work, the incidence of *Aphelenchus fragariae* has been determined.

The more recent observations on the occurrence of *Aphelenchus fragariae* in strawberry plants have raised considerable doubt as to whether this pest is the causal organism of "Red Plant" and "Cauliflower" or one merely associated with such pathological forms, and have rendered imperative further attempts to induce the diseases in healthy plants by direct mass infection with the eelworm. Further infection experiments have therefore been commenced in which the eelworms, suspended in water, have been introduced into the leaf axils and growing point regions of healthy plants. In all experiments several infections were made on each plant. Infections of runners from healthy plants have also been attempted by pegging down the young runners at the earliest possible dates in sand contained in pots and watering the sand periodically with suspensions of eelworms in water. Eelworms were also introduced into the axils of the leaves of healthy maiden plants before any runner stolons had appeared and the runners subsequently developed from these were pegged down for examination at a later date. All infected plants have been retained for prolonged periods of observation.

In addition to the above infection experiments, detailed examinations have been made of parent plants, their runner stolons and the

runners with a view to determining the distribution of eelworms in these portions of the plants during the period of runner formation.

It is hoped that the above mentioned experiments will provide evidence to enable a decision to be made as to whether *Aphelenchus fragariae* is the cause of " Red Plant " and " Cauliflower " or whether the high numbers of *Aphelenchus fragariae* invariably present in these forms are due to the fact that these types of plants provide especially suitable environmental conditions for the rapid reproduction of the organism.

Since there is a possibility that " Red Plant " is a diseased condition resulting from infection of the healthy plant with a definite virus, inoculations have been carried out in an attempt to transmit the disease from affected plants to healthy plants. The results have been in all cases negative after two seasons observations and, while they do not rule out entirely the possibility of the " disease " belonging to the virus category, they show that it is not likely to be of the type which is transmissible by inanimate objects.

The details of the inoculations were as follows, the variety used in both experiments being Royal Sovereign.

1. *Inoculations with Plant Extracts.*

The extracts were prepared from petioles, leaves and crowns of strawberry plants showing marked " Red Plant " symptoms. The portions of plant were ground up with cold water and squeezed in a muslin bag. The expressed juice was forced through a Chamberland filter and in this way an extract free from spores and bacteria was obtained. Part of the extract was boiled and used for control experiments. Injections were made into the bases of developing leaves by means of a hypodermic syringe delivering approximately 0.1 c.c. of extract for each inoculation. In all, 142 plants were inoculated by this method—77 two-year old plants and 65 maidens. Control inoculations were made on 134 plants.

2. *Tissue Inoculations.*

For each inoculation a small plug of tissue was cut with a cork borer (diameter 4 m.m.) from the side of a healthy crown and into the hole was inserted a similar plug cut from the crown of a " Red Plant." After the inoculation the wound was immediately covered with grafting wax. As controls, plants were treated in a similar manner, but plugs from healthy crowns were inserted. Forty-seven plants were inoculated in this way—22 maidens and 25 two-year old plants. Forty-six plants were used as controls.

Strawberry Aphis (Capitophorus Fragariae).

In the investigations on strawberry aphis attention has been devoted mainly to infection experiments, which have shown the aphis to be the cause of a type of small leaf plant, and to following the course of aphis attacks in detail on several beds over a period of several seasons in order to determine the stages through which infested plants pass from the time of planting until death. Records taken on several thousand plants show that the " small leaf " stage is produced in the autumn as the result of aphis infection in the previous spring and that these small leaf plants do not recover in spite of the fact that, having reached the small leaf stage, they do not subsequently become infected with aphis. It has been found invariably that on beds containing both healthy and small leaf forms the aphis attacks only the healthy plants.

Experiments with the object of controlling the aphis have been carried out. These have shown that the young plants may be assured a good start free from the pest by dipping the runners before planting, in a solution of nicotine (98 per cent. strength) and soft soap, using the nicotine at the strength of $\frac{1}{2}$-oz. per 10 gallons of water. Experiments are in progress in which nicotine sprays and dusts are being used to determine suitable methods of controlling the aphis during the later stages in the life history of the plant.

Root and Crown Rots.

In a consideration of strawberry root rots, the structure of the normal tissues calls for mention. A strawberry root more than two months old shows a well marked polyderm, a cylinder with alternate layers of starchy and of suberised cells, laid down around the inner margin of the cortex. As the suberisation becomes complete, the cortex is cut off from the vascular tissue of the root and in consequence dies. The dead cortex turns brown, becomes invaded by bacteria and fungi and, as rotting progresses, gradually blackens. Within the discoloured layer, however, the " core " of the root remains white and healthy, the corky layers of the polyderm forming an effective barrier to penetration by bacteria and fungi. It is to be noted that the presence of micro-organisms in the cortex of the roots after the formation of the suberised layer is a normal occurrence, having no adverse effect on the plant.

Pathological symptoms in strawberry roots are (1) the blackening of young roots, i.e., those under two months old, (2) discolouration of the vascular tissue. These symptoms are common in plants suffering from waterlogging, " Patch," " Small Leaf " and " Sudden Wilt." With the possible exception of " Sudden Wilt," the diseased condi-

tions mentioned do not appear to be due primarily to fungal attack. Generally speaking, attempted isolations from discoloured vascular tissue in the roots of such plants are negative: from the cortical tissues of young blackened roots a variety of fungi and bacteria may be obtained, but *Pythium proliferum* and *Diplodina lycopersici* have not been found in any material examined at Long Ashton. It is suggested that the fungi present in rotted roots of "Small Leaf," "Patch" and waterlogged plants follow upon, rather than initiate, the death of the tissues.

The strawberry crown in the normal condition is sheathed with semi-decayed petiole and stipule bases, permeated with mycelium and bacteria, but disease due to invasion of the actual crown tissue by micro-organisms appears to be infrequent. The only type of crown rot due to fungi which has been noted at Long Ashton is an attack by *Armillaria mellea* on plants already enfeebled by age and neglect. The fungus grows upwards from the base of the crown, replacing the host tissue by conspicuous plates and tongues of white mycelium. Identification of the fungus was made on cultural characters, in particular the production of rhizomorphs.

Attempted inoculations have not been successful and there is little doubt that the attack of *Armillaria mellea* on strawberries is to be looked upon as exceptional. The affected plants at Long Ashton had been grown on newly broken ground near the site of a hedge: under such conditions, it is possible that woody debris attacked by *Armillaria mellea* was present in the soil, and served as a source of infection.

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INVESTIGATIONS ON THE FUNGICIDAL ACTION OF SULPHUR.

Progress Report.

By B. T. P. Barker.

Introduction.

The first progress report on this subject was published as a joint paper by Messrs. Gimingham and Wiltshire and the present writer in the Annual Report of this Station for 1919. The departure of the two former from the Station shortly afterwards and the calls of other duties on the time of the remaining author resulted in the continuation of the investigations being largely intermittent. The greater part of the subsequent experimental work has been mainly carried out by Mr. W. Camps, the writer's personal research assistant : he has been responsible in addition for many suggestions and has followed up several of these with independent experiments. Mr. R. W. Marsh, the present research mycologist at the Station, has also been closely associated with the later developments of the investigation. It is not proposed to deal in detail with the latter on this occasion, the purpose of the present report being to carry the account of the work to the stage where it has been proved that under suitable conditions sulphur yields a product of highly toxic properties.

In the course of the first progress report it was shown (*a*) that all sulphur and polysulphide sprays depended for their lasting action on a more or less finely divided coating of sulphur distributed over the treated plant, (*b*) that there was no evidence either of the solubility of sulphur in any way sufficient to exercise direct toxic effect on fungi or of the conversion by atmospheric agency of that substance into a gas or a soluble derivative in quantity significant for fungicidal purposes, (*c*) that sulphur could distribute itself over considerable distances in a form which is not a true gas or vapour and (*d*) that when sulphur is in close proximity to a living fungus spore it exercises by some means a definite toxic influence upon the latter.

The subsequent investigations have been concerned chiefly with further work arising under the three latter heads, (*b*), (*c*), and (*d*).

A very long period was devoted in the first place to that under (*b*), with comparatively little result from the point of view of the main question at issue, although in the end the absence of results of a positive character fitted in appropriately with the very positive results secured later under (*d*). Little further reference need therefore be made here to that side of the work.

The Movement of Sulphur through Space.

Before the collaboration between Messrs. Gimingham and Wiltshire and the present writer ceased, additional work under (*c*) had served to indicate the actual form in which sulphur distributes itself across space. Reference to this part of the research and to some of the critical experiments involved has already been made in a paper contributed by the writer to a discussion upon the fungicidal action of sulphur at a meeting of the Association of Economic Biologists held in 1925. A report of this discussion was subsequently published in the Annals of Applied Biology (Vol. XIII. 1926, p. 308). The present position of the state of knowledge on this section of the subject may be summarised briefly as follows.

Sulphur is dispersed through space from any of the ordinary forms of the solid substance, such as flowers of sulphur, precipitated sulphur, roll sulphur, etc., in the form of minute solid particles, which under appropriate conditions appear to emanate from the parent mass continuously. Moisture and a high temperature particularly appear to favour the discharge. The dispersion of sulphur in this manner is not unique, corresponding behaviour by other elements such as gold and arsenic having been previously discovered by other workers. No serious attempt has been made to examine the size of the particles at the moment of dispersion, although a sample collected on a glass slide and examined microscopically shows the finest of those thus collected to be so small as to require the highest powers of magnification for them to be visible. On the slide a tendency to aggregation has been noted and it is thus possible that even the finest of those observed are in reality aggregates of a still smaller original form.

In no case has the movement of sulphur through space in any form other than this " particulate " state been demonstrated and no evidence has been secured to suggest that it passes at ordinary temperatures in detectable quantities as a gas or vapour. The critical tests in this connection have been the following :—

(1) Moist sulphur has been exposed to air in a confined space and pieces of bright copper foil and copper wire have been suspended in the chamber at some distance away

from the sulphur, in some cases directly exposed to the air of the chamber and in others protected by a wrapping of a coarse cellulose paper to serve as a filter. In the former the bright copper surface has quickly become tarnished with a superficial film of black copper sulphide: in the latter it has remained bright indefinitely. In other words the filter pad of cellulose has sufficed to remove the sulphur from the air passing through it.

(2) A similar result has been obtained when the chamber has been composed of two sections, the sulphur-containing part being connected with the other by means of a straight glass tube of fairly wide bore in the one set of trials and a similar glass tube bent at an acute angle in another set. The copper in the distal section of the chamber became tarnished in the former set, but remained bright in the latter set on account of the particulate sulphur being trapped by the bend in the tube and deposited on the inner surface of the glass in the region of the sharp bend, where its presence was demonstrated microscopically and chemically.

(3) Similar results were obtained by a biological method, wheat infected with *Erisyphe graminis* showing a vigorous growth of the fungus in analogous cases to those in which the copper remained bright, i.e. where the air was filtered by a cellulose pad or bent tube, and a definite destruction of the parasite under the set of conditions showing the tarnishing of the copper.

In a comparatively open space such as a greenhouse, and also in the open air, it is obvious that the discharged particles can be conveyed to considerable distances by currents of air and it is evident that the protective action against fungoid diseases in greenhouses brought about by the coating of the hot water pipes with a sulphur paste, or by the simpler method of placing shallow dishes containing moistened flowers of sulphur at different points about the house, can be accounted for in this manner by the actual conveyance of elemental sulphur to the surfaces of the plants contained in the house.

The nature of the discharge and the force with which the particles are dispersed have not been closely investigated so far, but the following experiment is suggestive in the latter connection. In a 5ft. long glass tube of 3 inch diameter, sealed at both ends and supported in a vertical position, moistened sulphur was placed at

the lower end and a long chain of bright copper wire suspended from the upper end. the tube was kept in a laboratory of even temperature, so that the possibility of air currents within the tube was eliminated. The chain became uniformly covered with a coating of copper sulphide throughout its whole length in the course of a few weeks. It would appear therefore that the particulate sulphur is discharged with some force and to some distance.

The existence of sulphur in so fine a state of division having been proved, the question arose as to the possibility of the toxic action being directly associated with the particulate condition on account of the known special properties and chemical activity of other elements when in a particulate state. Accordingly efforts were made to devise a method of charging the atmosphere of suitable containers with particulate sulphur to different extents with the object of ascertaining if the degree of fungicidal toxicity within the respective containers was related to the density of the charge. This line of work also involved the development of a suitable method of chemical analysis for the quantitative determination of the particulate sulphur present in the individual cases. Although a very long period was spent upon this section of the work, which was particularly difficult on account of the minute amounts of sulphur which have to be estimated and the consequent extreme delicacy requisite in the method of analysis, it had yielded little result of material bearing upon the main subject by the time a series of facts discovered along another line of investigation brought to the fore another aspect of the nature of the fungicidal action.

The Interaction between Sulphur and the Living Plant.

Mention has already been made above to the conclusions that for a fungus spore to be toxically affected by sulphur it was necessary that it should be very closely adjacent to the fungicide, and that no clear evidence had been obtained to show that sulphur without this close association produced any significant amount of any toxic substance. The discovery of particulate sulphur having indicated a method by which sulphur could come into intimate contact with all superficial parts of the host plant and with any fungus upon its surface, further investigation of possible interaction between the living organism and sulphur itself was undertaken. This followed two main lines, one being concerned with a possible reaction between the host plant and the fungicide and the other similarly between the fungus and the fungicide. The results along both these lines, as will be seen in due course, lead to the same general conclusion.

Dealing first with the experiments on the host plant, the earlier work was done with apple foliage and begun towards the end of the growing season. Leaves were removed from healthy trees, dusted with flowers of sulphur on both upper an lower surfaces, and various tests then applied to determine if any derivative of sulphur of possible toxicity could be detected. The results as a whole were of a negative character, although in a few instances when the treated leaves were clamped between layers of moist lead acetate paper a slight discoloration indicative possibly of a trace of sulphuretted hydrogen was observed. Since the leaves at that stage of the season usually carried some slight damage due to insect puncture or other agency, it seemed possible that under the conditions of the tests material from the inner tissues might be exuded through the injured spots to react with the sulphur and produce the discoloration. Hence several leaves were ground to a paste and sulphur added to it, but no clear-cut result was obtained. When, however, the youngest and soundest leaves on a tree were similarly dusted with sulphur on both surfaces and left attached to the tree, definite although not absolutely conclusive indications of sulphuretted hydrogen production were obtained.

The onset of autumn prevented further progress with these experiments in the foliage of deciduous trees that season, but early the following spring the experiments were repeated in the laboratory on young strawberry plants in pots just beginning to throw up new and vigorous young foliage. With this material the results from the outset were most definite and convincing. The youngest leaves showed an intense brownish-black stain on the lead acetate paper on the under-side of the leaf, but no clearly marked discoloration on that on the upper side except in the accidental cases where a small portion of the edge of the under-side had been accidentally reverted in the course of clamping on the paper for the test. For older leaves the results showed a definite weakening of the reaction, which was progressively less as the age of the tested leaves increased until finally with the oldest leaves on the plant no reaction occurred.

These tests with strawberry plants have been repeated during the further course of the investigation a very large number of times with corresponding results, and the following general conclusions can be considered as well established.

(1) Before any clear reaction whatever can be obtained the plants must have passed from the dormant winter condition to that of active renewed growth. After the vigorous growth period begins to slow, down the intensity of the reaction correspondingly diminishes and ultimately fades to nothing as the dormant season approaches.

(2) Similarly the most intense reaction is invariably shown by the youngest, most actively respiring leaves. As they age, the reaction diminishes progressively and finally does not occur.

(3) The reaction only occurs on the underside of the leaf, i.e. the stomatal side in the case of the strawberry. The presence of stomata appears to be necessary for the reaction.

(4) The reaction appears equally vigorous whether the plants are kept in light or darkness during the period of test. It is also freely given by plants kept in darkness for some days before the application of the test.

(5) To secure the reaction, it is necessary that the tested leaves should remain attached to the parent plant. In no case has a conclusive positive test been obtained with detached leaves.*

(6) There is no question of injury to the superficial tissues of the leaf playing any part in the reaction. The youngest, absolutely uninjured leaves give the most intense results.

(7) Although tests for possible sulphur derivatives other than sulphuretted hydrogen have been frequently made, in no case has there been any indication of their formation.

Similar results have been obtained with several other plants besides the strawberry, representing as widely separated Natural Orders as the *Gramineae*, *Rosaceae*, and *Ribesiaceae*. The strawberry, however, has proved to be the easiest and most satisfactory plant to work upon and has given the most striking results.

There has been no reason to suppose that the reaction obtained with lead acetate is due to any substance other than sulphuretted hydrogen. It may be possible that the sulphur compound formed is a volatile organic sulphide, but the later work yet to be described proves it to be a true gas at ordinary temperature and no fact has yet been observed suggesting that it is not sulphuretted hydrogen.

In the simplest form of conducting these tests on the interaction of living foliage and sulphur the lead acetate paper was clamped directly on to the leaf surfaces. For further experiments in this direction designed to determine certain specific points somewhat different procedure was necessary. In those cases a shallow glass

*Since this Report was written, a positive result with detached strawberry leaves has been obtained when they were severed from the parent plant by cutting the petioles under water. In all previous tests the severance was made without such immersion.

chamber was devised, into which the leaf under test could be inserted while still attached to the parent plant. A small circular opening about half an inch in diameter cut in the upper glass side of this chamber at the end remote from the inserted leaf permitted the volatile sulphur product to escape at that point and a series of tests to be made upon it without any possible complicating effect of direct contact of the test material with either the leaf or the sulphur. Any particulate sulphur which might otherwise have been carried through that orifice was trapped at that point by covering the opening with a small cellulose pad as filter. Two tests only need be described here. In each case the opening was made the means of communication between the main chamber containing the leaf and a small ante-chamber consisting of an ordinary van Tieghem cell, such as is used by mycologists for hanging drop cultures. The cell was sealed to the outer surface of the glass above the opening and was of such a size as to surround it completely. In the one test a lead acetate paper was used to form the lid of the cell and a characteristic blackening followed, indicating the escape of the sulphur product from the leaf-containing chamber through the cellulose filter pad into the cell and proving it to be a gas at ordinary temperatures and probably sulphuretted hydrogen.

In the other test the cell was used in the usual way for a hanging drop culture, which in this case consisted of a thin film of water containing a suspension of living conidia of *Monilia fructigena*, a fungus shown in the course of the earlier work to be particularly susceptible to sulphur action. Under these conditions germination of the conidia was prevented and death ultimately resulted, thereby proving the toxicity of the gaseous sulphur product.

In view of the divergent conclusions as to the toxicity of sulphuretted hydrogen which have been arrived at by previous investigators on that point, it appeared necessary in conjunction with the results just described to reinvestigate the action of that substance on fungi. For this purpose the present writer arranged with Mr. R. W. Marsh, the research mycologist at this Station, to carry out the necessary tests. The latter's results, which are now complete, are being prepared for publication and the only reference to them required here is a general statement that the fungicidal action of this gas has been proved to be considerable and that the quantity formed by living leaves under the conditions described above is sufficient to be definitely toxic, as indeed the hanging drop test just recorded clearly shows.

The second line of work on the interaction of living organisms

and sulphur referred to earlier in this paper has dealt with direct tests on fungi. In the first progress report a considerable amount of evidence was given to show that for some fungi the presence of sulphur in close proximity to a spore resulted in the death of the spore or at least inhibition of germination, and that there was no evidence to show that sulphur independent of the organism was producing any toxic substance. Further work on cultures of fungus mycelium grown in bulk and lightly dusted with sulphur in various forms has proved the formation of sulphuretted hydrogen by the lead acetate paper test carried out in a somewhat similar way to that described in the tests with the sulphured leaves. Both in these cases and with the work on leaves, control tests made on unsulphured material gave negative results, so there is no question that the sulphuretted hydrogen produced is the direct result of interaction between the living organism and the sulphur. Since it is not intended to proceed beyond the establishment of that conclusion in the present article a more detailed reference to the tests on fungi is not required here.

The further investigations still in progress are largely concerned with the manner in which this reaction is brought about. They are at present incomplete and the tentative conclusions already formed will be withheld until a later occasion, when it is hoped that the necessary complete chain of evidence to justify their presentation will be available.

In a progress report of this character it would be inappropriate to embark upon a detailed critical review of previously published work bearing upon the question of the fungicidal action of sulphur. Since, however, the results herein presented lead to a conclusion so divergent in character from that arrived at recently by Young (1), a brief reference to the latter is unavoidable. According to that author the degree of fineness of division of sulphur is important and the study of colloidal sulphur on that account is especially significant. He classes colloidal sulphur into two types, the " hydrophilic " and the " hydrophobic," the former being extremely toxic to all the organisms used in his tests and the latter being slightly more toxic than finely ground flowers of sulphur, which in turn he finds more toxic than unground flowers, but only at a hydrogen-ion concentration of pH 4.0—5.5. His conclusion is that toxicity is due not to SO_2, SO_3 or H_2S, or any of the common acids or oxides of sulphur, or to the sulphur particle, but to pentathionic acid, an oxidation compound which he claims to be formed from sulphur and water. His work and conclusions are open to

(1) H. C. Young.—The Toxic Property of Sulphur. Annals of the Missouri Botanical Garden, November, 1922. Vol. IX, No. 4.

criticism in several respects, and possibly the most vital in this connection is that, according to his own showing, pentathionic acid is destroyed when in a solution of higher or lower hydrogen-ion concentration than pH 4.2—5.4. This clearly limits very considerably the conditions under which sulphur can exert its toxic action, if the pentathionic acid hypothesis is correct, and certainly leaves unexplained the Long Ashton results where toxic effects have been secured at hydrogen-ion concentrations outside that range. Moreover the recent work at this Station makes it inevitable that sulphuretted hydrogen must come into account once more after many years as one of the toxic products of sulphur fungicides, if not indeed the only one. As Marsh's work on the toxicity of this gas will show, when published, Young's conclusion with regard to it is untenable and the tests upon which it was based are inadequate.

INVESTIGATIONS ON TAR DISTILLATE AND OTHER SPRAY LIQUIDS, PART I.

By Frank Tutin.

I. Improvements in the Method of Preparation of Tar Distillate Spray Liquids.

The investigation of tar distillate spray fluids was commenced by the present author in 1921, when the first product of this nature was introduced to this country from Holland. On examination, this product was found to contain from 80-90% of a tar distillate, the remainder of the mixture consisting of resin soap and water. The tar distillate boiled from about 190°-360°C. and contained about 10% of its weight of " tar acids " (cresols, etc.). Since it seemed highly probable that, in such a mixture of compounds as is represented by this tar distillate, the various components would differ in their toxicity towards insect eggs, a sample of a tar distillate of similar boiling point was obtained and separated, to some extent, into its various components. It was then sought to emulsify the various products obtained, but satisfactory emulsions could not, at first, be prepared. Some preliminary trials against eggs of the permanent apple aphis, however, appeared to indicate that the portion of the distillate of higher boiling point was the most toxic, and, moreover, that such a product when deprived of " tar acids " appeared to be at least as toxic to the eggs, if not more so.

It was not possible at that time, however, to give detailed attention to the problem of the proper emulsification of these tar distillate products, but in the autumn of 1925 special facilities were provided for the work by the aid of a grant from the Ministry of Agriculture and Fisheries. A short account of the investigation then conducted has already been published by Dr. L. E. Smith.* This investigation rendered it evident that it was desirable to investigate more fully the egg-killing properties of certain products obtained from the tar distillate and, for this purpose, a further grant was subsequently made by the Ministry. The results of this new work are given below.

* Annual Report of the Long Ashton Research Station, 1926, p. 82.

Toxicity towards Winter Moth Eggs of Various Tar Products.

The material employed for the greater part of this work was a vertical retort tar boiling from 190° to 360°C. and which contained nearly 20 per cent. of " tar acids." Some basic material (quinoline, etc.) was also present in the tar distillate but this was removed, and not further examined, since these bases are known to be practically valueless for egg-killing purposes. The " tar acids " were then separated from the neutral material and both of these products were submitted to fractional distillation. The neutral material was divided into two fractions ; one boiling from 190°-280° and the other from 280°-360°. The lower boiling material, on cooling, deposited napthalene, whilst that of higher boiling point yielded anthracene. Both these solid products were removed, the liquid portions of the distillate only being employed for the subsequent experiments and are referred to later as the " low neutral " and " high neutral " respectively.

The " tar acids " were separated into four fractions, boiling respectively from about 190°-220° ; 220°-250° ; 250°-280° ; 280°-360°. The two intermediate fractions were relatively small and were not further employed. The fraction boiling at 190°-220° consisted essentially of cresols and is referred to subsequently as the " low phenols " ; that boiling from 280°-360° is referred to as the " high phenols."

For the purpose of ascertaining the relative toxic properties of these products, five emulsions were prepared with the aid of castor oil soap :—

1. An emulsion of the total distillate. This is a product comparable to the tar distillate spray liquids at present in use.
2. An emulsion of the " low neutral."
3. An emulsion of the " high neutral."
4. An emulsion of the " low neutral " + 20 per cent. of " low phenols."
5. An emulsion of the " high neutral " + 20 per cent. of the " high phenols."

These products were tested against eggs of the Small Winter Moth. A large number of tests were made, about 5,000 eggs being employed. Six batches of eggs kept as controls gave hatches varying from 80-100 per cent., the average being over 90 per cent. The emulsions were employed in two concentrations, 5 per cent. and

8 per cent. The results obtained are summarised in the following table :—

	Emulsion I.		Emulsion II.		Emulsion III.		Emulsion IV.		Emulsion V.	
Strength	5%	8%	5%	8%	5%	8%	5%	8%	5%	8%
Percentage hatch.	2.9	1.5	3.2	0.4	0.0	0.0	13.9	1.9	0.3	0.0

These results are entirely in harmony with results of a preliminary nature which had previously been obtained by smaller-scale trials against eggs of the Permanent Apple Aphis. Other batches of winter moth eggs were also sprayed at the same time with one of the best-known brands of " carbo " washes and with the dinitro-cresol preparations supplied from the Rothamsted Research Station. The results clearly showed the superior egg-killing powers of the above-described emulsions III and V, the nitro-products in particular being relatively ineffective against Winter Moth eggs.

Two outstanding conclusions may be drawn from these results : firstly, that the portion of the tar distillate boiling *above* 280° is more toxic to eggs than is the material of lower boiling point or the total distillate ; and, secondly, that the addition of phenols (" tar acids ") to the neutral materials actually *lowers* the toxicity of the product. The material most toxic to eggs is therefore seen to be the liquid, neutral constituents of the tar distillate boiling between 280° and 360°.

A New Method of Emulsification.

The above-described experiments having shown clearly that the portion of the tar distillate having the greatest egg-killing powers is the neutral constituents of high boiling point, it was therefore considered desirable to devise a method by which this neutral product could be emulsified in a satisfactory manner.

In the preparation of the above emulsions, considerable difficulty was experienced with the products consisting of neutral materials only. Castor oil soap was found to be the most efficient soap that could be obtained, but even when employing this it was found only just possible to prepare emulsions that were sufficiently stable for the above-described trials against Winter Moth eggs. An emulsion of the neutral material sufficiently stable to be employed on the commercial scale could not be prepared by the employment

of any soap. This is owing to the fact, rendered evident by the work of Dr. Smith (*loc. cit.*), that the preparation of a tar distillate spray liquid which will yield a good emulsion on dilution with water depends on the establishment of a certain balance between the particular soap solution used and the " tar acid " content of the tar distillate, whereas the product which it was now sought to emulsify was devoid of " tar acids." It was therefore necessary to find a new emulsifying agent that would give the desired result. This has now been done: two products, viz., two sulphonated oils known as Agral WB and Agral AX respectively, are both capable of readily giving perfectly satisfactory and stable emulsions with any neutral product. The Agral AX is a cheaper product than the Agral WB, but it appears to behave in all respects similarly to the latter, and yields emulsions which seem to be equally permanent. The conditions under which satisfactory emulsions can be prepared with the aid of Agral WB have been very fully studied and the behaviour of this emulsifying agent is therefore dealt with at length in this paper.

If to 10 parts of the " high neutral " tar distillate one part of Agral WB and one part of 20 per cent. aqueous NaOH be added a homogeneous product is obtained which will yield a good emulsion with water. The product so obtained is rather too viscid, however, to be very convenient for use, and it also requires rather much shaking with water for the production of an emulsion fit for practical use, and even then the droplets of oil in the emulsion are rather larger than is desirable and tend to deposit in the form of a sludge. The most convenient method of preparing a good, stable emulsion was found to be to dissolve the Agral WB in the " high neutral " tar oil, add the desired volume of water, and then introduce the requisite amount of alkali, preferably previously dissolved in a little of the water. The very minimum of agitation will then produce a white emulsion which is permanent even after exposure to the air for months. When using distilled water, or a very soft water, it was found that perfect emulsions could be made when the proportion of Agral WB was only 5 per cent. of the " high neutral " tar oil but with the majority of waters it is desirable to use as much as 10 per cent. The conditions for obtaining good emulsions will be best understood by reference to the following experiments and plates.

One half a c.c. of a 10 per cent. solution of Agral WB in the " high neutral " tar oil was introduced into each of the test tubes shown in Plate I., Fig. I., 10 c.c. of distilled water was then added to each. Alkali (NaOH) dissolved in a little water was then introduced and the mixtures shaken once. The amounts of alkali added to the 12

tubes were, from left to right, 0.005, 0.01, 0.03 ; 0.05 ; 0.07, 0.09, 0.11, 0.13 ; 0.15, 0.17, 0.19 and 0.21, of a gram respectively. Fig. II. shows the same tubes after keeping, without agitation and exposed to the air, for 36 days. The photograph represented in Fig. I. was taken soon after preparation of the emulsions, and it will be noticed that froth remains on some of the tubes and that the two emulsions containing the highest amounts of alkali are not good. In Fig. II. it will be seen that the only noticeable change that has taken place on keeping is that the emulsion with lowest alkali has deposited some creamy sludge whilst the two with the highest amounts of alkali have improved with keeping. In the interval of time which elapsed between the " taking " of the photographs represented in Figs. I. and II. (Plate I.) there was, for a short period, a slight sedimentation of emulsions 2, 3 and 4, but this was soon remedied spontaneously. The amount of alkali which it is necessary to add bears a direct relationship to the amount of Agral WB present in the emulsion prepared. When making a 10 per cent. emulsion it is therefore necessary to employ twice the amount of alkali used in the above 5 per cent. emulsions. The fact that these emulsions are permanent on exposure to air, when, of course, they are able to absorb carbon dioxide, indicated that sodium carbonate, in chemically equivalent amount, might be substituted for the sodium hydroxide which had been used. Actual experiment proved this to be the case.

The Effect of " Hardness " of Water.

The effect of " hardness " of the water employed in making the emulsions was then investigated. Bristol tap water, which is very highly charged with lime, was first employed. It was then found that it was necessary to employ a slightly higher minimum amount of alkali than was used in making the emulsions shown in Plate I. Otherwise, the results were much the same. In order to ascertain if it were possible to prepare emulsions with the aid of Agral WB using a most exceptionally hard water a sample of water was obtained from a dyke on the farm of Mr. H. S. Willatt, of Begdale, Elm, near Wisbech. This water, on analysis, was found to contain 431 parts per 100,000 of dissolved salts, and 131 parts of $''SO_4$ and 113 parts of $'Cl$. It was found impossible to prepare with this water emulsions of the usual tar distillate spray liquids, nor would it give an emulsion with the " high neutral " tar distillate and Agral WB under the same conditions as were satisfactory when using tap water. It was found necessary, therefore, to increase the concentration of Agral WB, and consequently also of alkali, with respect to the proportion of *water* used. Thus when using an amount of Agral WB equal to 10 per cent. of the " high neutral "

tar oil a good emulsion of 20 per cent. strength could be prepared. For a 10 per cent. emulsion it was necessary to use 20 per cent. of Agral WB, and for the preparation of a 5 per cent. emulsion 40 per cent. of Agral WB had to be added to the tar oil. Thus in all of these emulsions made with the Wisbech water, the proportion of Agral WB in the emulsion remains constant as must also, consequently, that of alkali, irrespective of the amount of " high neutral " tar oil present. These emulsions may be diluted with distilled water, but dilution with Wisbech water causes de-emulsification unless more Agral WB and alkali be also added.

Summarising the foregoing results, it is seen that, for general purposes, 10 per cent. of Agral WB should be added to the " high neutral " tar oil, water added to make an emulsion of the desired strength, and then alkali introduced. The amount of alkali (NaOH) required to be added should be from 0.6 to 1.8 grams per c.c. of Agral WB present in the emulsion. When using an excessively hard water, however, the proportion of Agral WB and alkali must be increased in relation to the amount of water used. The concentration of free alkali in the finished emulsion, however, is much lower than that represented by the amount added, since the greater part is neutralised by the Agral WB, the latter compound partaking of the nature of an acid. Emulsions prepared in this manner are not affected by the absorption of CO_2, and, consequently, an equivalent amount of ordinary washing soda may be used instead of the sodium hydroxide.

Effect of Alkali Concentration on Emulsions of the Total Tar Distillate.

When preparing emulsions of the total tar distillate, containing the " tar acids," by the aid of Agral WB, a very interesting series of phenomena is observed. Plates II. and III. show a series of emulsions prepared from the total tar distillate which are exactly comparable to those shown in Plate I. prepared from the " high neutral " material. The first emulsion on the left in the Figures on Plates II. and III. contains too small an amount of alkali and gradually deposits a creamy sludge. The second and third emulsions are the only two of the series which are really permanent. On keeping, all those which have received higher amounts of alkali quickly darken in colour and then de-emulsify, a black, tarry substance, separating on the surface (see Plate II., Fig. II.). On further standing, however, re-emulsification soon takes place spontaneously, almost white emulsions being now formed. Then, on keeping for some time further, each of the emulsions from the fifth to the twelfth, in regular sequence, becomes slate-

coloured for a short period, then again becomes white, and then finally and permanently de-emulsifies downward. Some idea of these striking changes may be obtained from the series of photographs shown on Plates II. and III. which all represent the same set of emulsions at intervals over 36 days. There are certainly at least two chemical reactions involved in these changes. That occuring most rapidly appears to involve the absorption of oxygen, whilst the final change is due to saturation of the alkali with carbon dioxide. If sodium carbonate be substituted for sodium hydroxide in making emulsions of the total tar distillate, no emulsion can be formed if the equivalent proportion of the alkali used is greater than that employed in making the third emulsion shown in the plates.

Toxicity of the New Emulsions Towards Insect Eggs and Plants.

By the employment of Agral WB or Agral AX it has therefore been possible to prepare, in a few moments, perfectly stable emulsions of tar oil products (both neutral and containing " tar acids ") which contain no free caustic alkali and only a very small percentage of sodium carbonate. Such an emulsion, in 4 per cent. strength, of the " high neutral " material was therefore prepared and its toxicity towards insect eggs was compared with that of one of the best-known brands of tar distillate washes in 4 per cent. strength. The eggs employed in this case were those of the " Ringlet " butterfly. It was then found that whilst the 4 per cent. " high neutral " emulsion killed 98 per cent. of the eggs the commercial wash killed only about 45 per cent., thus again showing the much greater toxicity of the " high neutral " material.

As is well known, the tar distillate spray liquids at present on the market can only be used on trees during the dormant period. If applied after the buds begin to break, considerable damage generally results. It is also known that the " tar acids " are very damaging to plants, and it has been shown above that their presence is not desirable from an egg-killing point of view. It seemed possible, therefore, that the above-described " high neutral " product, whilst being more toxic to insect eggs, might be less toxic to the plant than are preparations made from the entire distillate. Growing branches of a plum tree were therefore sprayed about the beginning of July with a 2 per cent. emulsion of the total tar distillate made with the aid of castor oil soap and with a 2 per cent. emulsion of the " high neutral " material made with Agral WB. It was then found that the emulsion of the total distillate caused such damage that all the leaves died, whilst not a trace of visible damage was caused by the " high neutral " spray. Several series of experiments were also carried out in which young mustard

seedlings were sprayed with 1, 2, and 4 per cent. emulsions of the " high neutral " material, " Carbo-krimp " and other preparations containing " tar acids." In each case the emulsions of the " high neutral " material were found to be distinctly the least toxic to the plant. For example, a 2 per cent. emulsion of the total tar distillate killed 85 per cent. of the mustard seedlings whilst an emulsion of the " high neutral " material of the same concentration, although it caused some damage to all the seedlings, did not kill any of them.

In addition to the above-described experiments, which were all conducted with products obtained from a vertical retort tar distillate, similar series of experiments have been conducted with horizontal retort tar distillate, and with diverse products from coke oven tar. The conclusion arrived at is that, for the purpose of obtaining suitable " high neutral " material, the source of the tar is immaterial. The liquid neutral material boiling from 280°-360°, which is the most valuable product for the preparation of an egg-killing wash, appears to be essentially the same whatever tar it is derived from.

When making emulsions from products containing " tar acids," it was noticed that a pink colour was always obtained with certain concentrations of alkali if the material had been derived from a fairly fresh, vertical retort tar, whilst this colour was not obtained from the other tar distillates employed. The colour, however, appears to have no significance from the " spray liquid " point of view: it is not permanent and is not given by an old, vertical retort tar to which air has had access.

Some large-scale field trials of the spray liquid made from the " high neutral " material with the aid of Agral WB are now in progress. In these trials, the relative efficacy of the new spray liquid will be judged by comparison with untreated trees and with trees sprayed with a well-known, commercial tar distillate wash.

Summary and Conclusions.

The results obtained with regard to the tar distillate spray liquids may be briefly summarised as follows—

The portion of tar distillates which is of most value for destroying insect eggs is the liquid, neutral material boiling from 280°-360° C. This high-boiling neutral product is also less injurious to plants than are spray liquids which contain " tar acids."

The presence of " tar acids " is also a disadvantage from the egg-killing point of view.

PLATE I.

FIG. I. shows 12 test tubes into each of which 0.5 c.c. of a 10% solution of Agral WB in the "high neutral" tar oil had been introduced. Ten cubic centimetres of distilled water and a small quantity of alkali (NaOH) has then been added to each and the mixtures shaken once. The amounts of alkali added to the 12 tubes were, from left to right, 0.005, 0.01, 0.03, 0.05, 0.07, 0.09, 0.11, 0.13, 0.15, 0.17, 0.19 and 0.21 of a gram respectively.

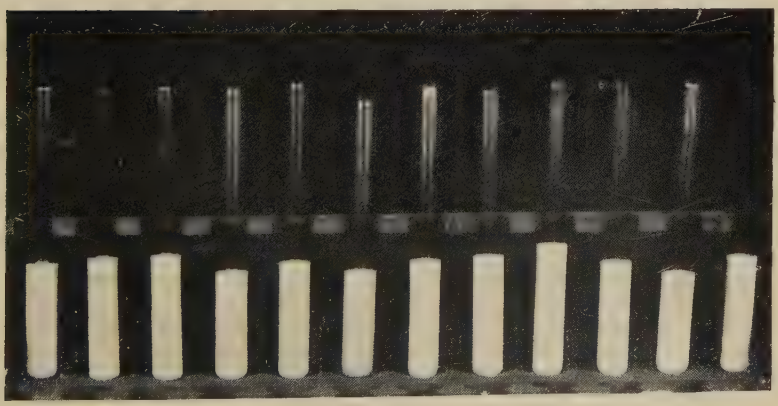


FIG. II. shows the same tubes after being kept, without agitation, for a period of 36 days.

FIG. I. shows a series of emulsions precisely similar to those shown in Plate I., Fig. I., except that the total tar distillate, containing "tar acids," had been used in place of the "high neutral" tar oil.

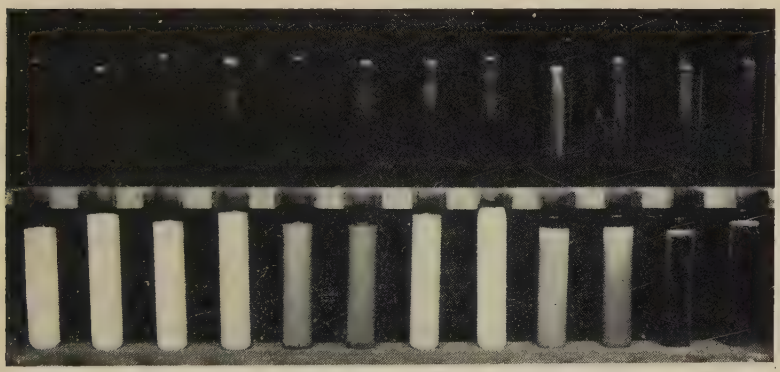


FIG. II. shows the same emulsions 23 hours later.

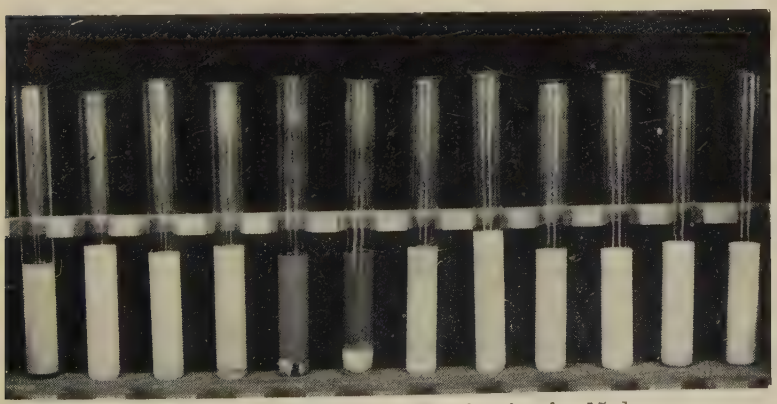


FIG. III. The same emulsions after keeping for 15 days.

FIG. I. shows the same emulsions as are depicted in Plate II. after keeping for 18 days.

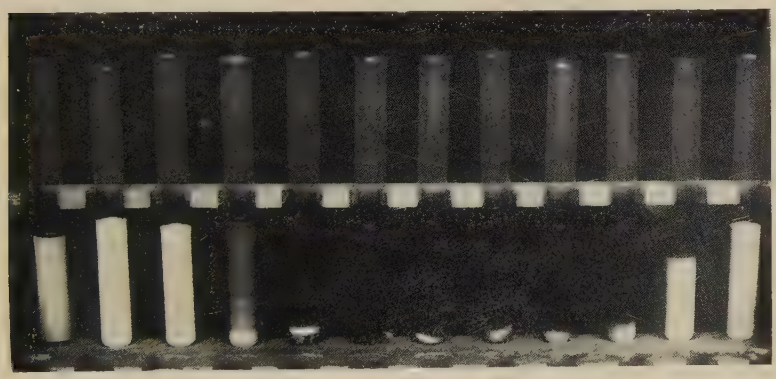


FIG. II. The same after keeping for 27 days.

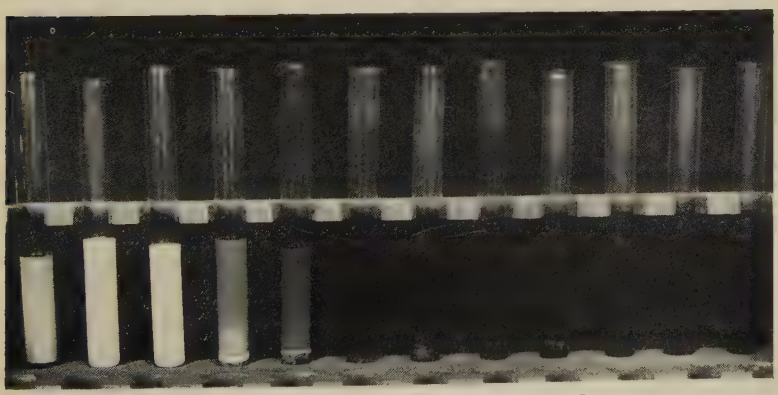


FIG. III. The same after keeping for 36 days.

The high-boiling neutral material cannot be emulsified satisfactorily by means of any soap, but perfect emulsions of it may be prepared by means of Agral WB or Agral AX. The most convenient method of preparing such an emulsion may be illustrated by the following example :—First mix the " high neutral " distillate with 10 per cent. of its volume of Agral WB (or Agral AX). To half a gallon of this mixture, add 9.5 gallons of water followed by about $5\frac{1}{2}$ ozs. of NaOH, and stir the mixture. The resulting emulsion appears to be stable for an indefinite period, even when exposed to the air. It is preferable first to dissolve the alkali in a little water. An equivalent weight of washing soda may be used in place of the NaOH.

The work on tar distillate spray liquids described in the present communication renders it apparent that it should be quite possible for the fruit grower to prepare for himself a standard tar distillate wash of proved efficiency should he wish to do so. It will only be necessary for him to purchase from one of the large gas companies a " high neutral " tar distillate such as has been described, mix it with the necessary emulsifying agent, and then add the desired amount of water and soda when required for use. The employment of the " high neutral " tar distillate in place of the total distillate should not necessarily add to the cost, since the constituent of the tar distillate which is of most value commercially is the " tar acids " (cresols) and this material will all be recovered. Moreover, the greater egg-killing powers of the " high neutral " material should render it possible to obtain a satisfactory control of insect pests by means of appreciably less concentrated sprays than are at present required, thus lessening the amount of material required to be purchased by the grower.

II. The Use of Agral WB and Agral AX in the Preparation of Other Spray Liquids.

It has been shown by Staniland* that certain oil sprays may, with advantage, be used to replace nicotine as cheap contact washes for Spring and Summer use against Aphids, Caterpillars, etc. Rape oil appeared to be the most promising oil investigated but difficulty was experienced in preparing it in the form of a satisfactory emulsion. It has now been ascertained that by the employment of Agral WB or Agral AX exactly in the manner described in connection with the " high neutral " tar oil a perfectly stable and satisfactory Rape Oil emulsion may readily be prepared. This method of emulsifying rape oil, or other fatty oil, has the advantage that the alkali is not added until the spray is required for use, thereby avoiding saponification of the oil taking place, as would be the case were a stock emulsion prepared containing one of the usual alkaline emulsifying agents.

* Annual Report of the Long Ashton Research Station, 1926, p.78

It has also been found that, apparently, any neutral liquid which is immiscible with water may be quickly emulsified by means of Agral WB. By this means stable emulsions have been made of a variety of fatty oils, paraffin, nitro-benzene, chloroform, carbon tetrachloride, carbon bisulphide, etc.

Very good emulsions of rape oil may also be prepared by mixing the oil with a half per cent. solution of Agral I to which a very small amount of alkali has been added. Alternatively, the Agral I, together with a trace of water, may be dissolved in the rape oil. This mixture will then give a good emulsion when shaken with water which has been rendered fairly alkaline. Agral I is a synthetic product prepared by the British Dyestuffs Corporation, Ltd., and has " wetting " powers much exceeding those of any known soap.

The exceptional wetting powers of Agral I suggested that it might with advantage be employed in connection with spray liquids for treating objects which are difficult to wet thoroughly, such as mildews and woolly aphis. Trials were therefore conducted against the last-mentioned pest with a nicotine solution of the usual strength to which half per cent. of Agral I had been added in place of soap. The results showed that the nicotine-agral I spray was decidedly superior to a nicotine-soap spray.

Summary.

It has been found that Agral WB and Agral AX are not only of use for the preparation of tar distillate emulsions, as described in the first part of this paper, but that they may, with advantage, be used for the preparation of a large number of other emulsions suitable for use as spray liquids. Thus with the aid of either of these preparations highly satisfactory emulsions of rape oil, or other fatty oils, and of such liquids as paraffin, carbon tetrachloride, nitro-benzene, etc., may readily be prepared. Rape oil emulsions may also be prepared with the aid of Agral I, a new preparation possessing great wetting powers.

Nicotine sprays prepared with Agral I, are more efficient against woolly aphis than are the usual nicotine-soap spray liquids.

Acknowledgments.

Thanks are due to the Chief Chemists of the South Metropolitan Gas Company, the Gas Light and Coke Company, and the Stavely Coal and Iron Company for kindly supplying the desired fractions of horizontal retort, vertical retort and coke oven tars respectively, and also to the British Dyestuffs Corporation, Ltd., for supplying the Agral WB, Agral AX, and Agral I, which have been employed in this investigation.

A BIOCHEMICAL NOTE WITH RESPECT TO AN APPLE TREE AFFECTED BY "SILVER LEAF" DISEASE.

By Frank Tutin.

In the Biochemical Journal for 1925, Vol. XIX., p. 414, the author published some observations regarding the pectin content of normal and "silvered" apple leaves. In this communication it was shown that leaves collected from a healthy branch of an apple tree contained appreciable more pectin than did similar leaves collected at the same time from another branch of the tree that was affected by "Silver Leaf" disease.

The tree in question was of the variety known as "Keswick Codlin" and was on its own roots. It had been trained as an espalier, and was evidently of considerable age, having a trunk 43 inches in circumference. A diagramatic sketch of the tree is given in Fig. 1.

When this tree first came under the author's notice, in 1920, the branches A and A.1. were badly "silvered" whilst the remainder of the tree appeared perfectly normal. The whole tree bore an abundant crop of fruit but the vigour of the diseased branches was noticeably less than that of those that were healthy. On the morning of July 22nd, 1924, leaves were collected from both sides of the tree in question and their pectin content was compared, with the following result :—

	Original weight of 40 leaves.	Weight of alcohol extracted marc.	Weight of pectin.	% of pectin in alcohol-extracted marc.
Normal leaves ..	35.15 grams.	7.70 grams.	1.30 g.	16.89
"Silvered" leaves	29.70 „	6.50 „	0.97 g.	14.90

During that year (1924) the branches A.1. (see fig.) died, and during the two following years the branch A, although continuing to crop well, appeared to decrease still further in vigour. In January, 1927, the dead branches (A.1.) were cut off near the main

trunk and a few weeks later the centre portion of each of the freshly cut areas became covered with the fructifications of the "Silver Leaf" fungus, *Stereum purpureum*, which, however, soon died. This appeared to be the end of the "Silver Leaf" disease affecting this apple tree, for, when the leaves developed on the branch A. they were no longer "silvered," and the new growth subsequently produced by that branch was equal in size and vigour to that formed on branch B, the whole tree appearing to be perfectly healthy for the first time in 8 years. Leaves collected from branches A and B respectively were therefore again compared chemically with respect to their pectin content, when the following results were obtained :—

	Original weight of 40 leaves.	Weight of alcohol-extracted marc.	Weight of pectin.	% of pectin in alcohol-extracted marc.
Leaves from A ..	27.10 grams.	5.93 grams.	1.00 g.	16.86
Leaves from B ..	27.18 „	5.94 „	1.00 g.	16.84

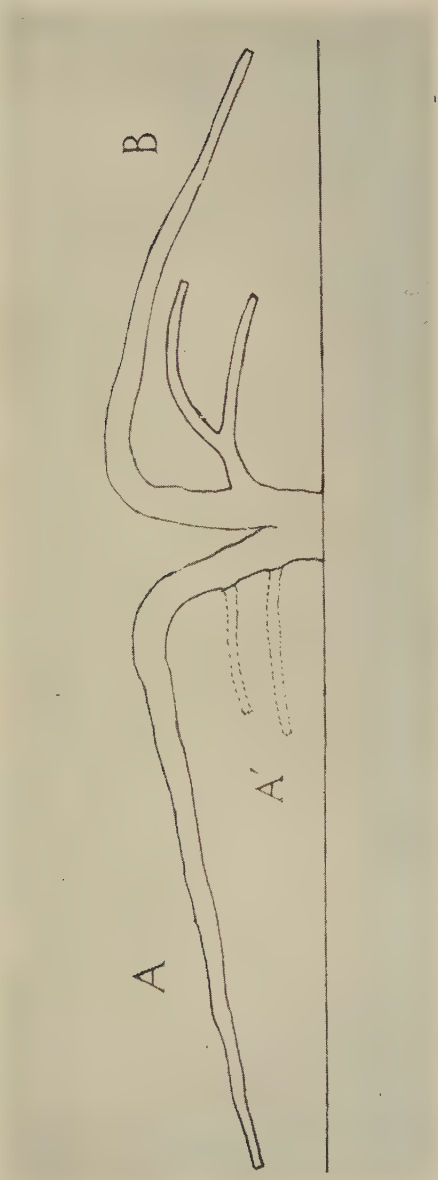
The separation and estimation of the pectin was conducted in the manner described in the previous communication (*loc. cit.*).

It is thus seen that the disappearance of "silver leaf" disease from Branch A, has been accompanied by a restoration of the pectin content of the leaves on this branch to the same level as that of the leaves of branch B, and that the leaves from both branches now had a pectin content practically identical with that of the normal leaves in 1924.

This affords confirmation of the conclusions previously arrived at : namely, that "silver leaf" disease in apple trees is accompanied by a deficiency of pectin in the leaves.

It will be noticed, however, that the average weight of the leaves collected in 1927, is appreciably less than was that of the leaves collected in 1924, although the composition of the normal leaves collected in both years is practically identical. This is doubtless due to a climatic influence. The leaves used for analysis in both years were those which had been fully grown by the middle of June. Although the hours of sunshine and mean temperatures experienced during May, and the first two weeks of June, in the two years under consideration, do not differ much, there was a great discrepancy in rainfall, that for 1924 being 7.81 inches, whilst during the corresponding period in 1927 only 1.36 inches were experienced.

Fig. 1.



INVESTIGATIONS ON DIE-BACK OF FRUIT TREES.

I. A PRELIMINARY EXPERIMENT AND SOME FIELD OBSERVATIONS ON *DIAPORTHE PERNICIOSA* AS A CAUSE OF "DIE-BACK" OF PLUM TREES.

(With One Text Figure).

By R. W. Marsh and R. M. Nattrass.

Inoculation Experiment with Diaporthe Perniciosa.

Prior to his departure in March, 1926, Dr. Briton-Jones, then Research Mycologist of the Station, planned an experiment further to test his conclusions previously arrived at, and set out in his recent paper on "Die-Back" of stone fruit trees (1).

In Dr. Briton-Jones' scheme thirty-five Czar plum trees, worked on "Compatible" and "Incompatible" stocks, were obtained from the East Malling Experimental Station, and were planted out under normal field conditions in the Long Ashton Research Station grounds. The trees on each type of stock were either (1) ringed or (2) left untreated. Certain of the trees in each of these groups were to be inoculated with *Diaporthe perniciosa*.

Since the departure of Dr. Briton-Jones, the following work has been done by the writers.

A strain of *Diaporthe perniciosa* was isolated from inner diseased tissue of a young plum tree showing the typical symptoms of "Die-Back." The isolation was made by planting out on agar small pieces of wood from the margin of the sunken portion of the main stem about one foot from ground level.

The culture obtained was grown on malt agar slants for 12 days and then used as the inoculum. Some days later the same culture developed both the (a) and (b) spores of the *Phomopsis* stage of *Diaporthe perniciosa*.

The ringing was carried out in July, and the trees were inoculated on the 25th August, 1926. The trees were ringed by making a "knife edge" cut about two feet above ground level. Inoculations

were carried out by making a small cut in the bark with a sterile scalpel and inserting a portion of the inoculum. The cuts were bound up immediately with rafia.

The controls were wounded by making in each a deep upward cut with a pruning knife, without any aseptic precautions and were left unbound.

The trees were examined on October 7th, and the following results were observed :—

Results of Inoculations.

	Scion.	Stock.	Treatment.	Result.
1	Czar	on Common Plum	Untreated	+
2	,,	,,	,,	+
3	,,	,,	,,	+
4	,,	,,	Ringed	+
5	,,	,,	,,	+
6	,,	,,	,,	+
7	,,	on Myrobolan	Untreated	+
8	,,	,,	,,	+
9	,,	,,	Ringed	+
10	,,	,,	,,	+
11	,,	on Black Damas	Ringed	Doubtful
12	,,	,,	,,	+
13	,,	,,	Untreated	+
14	,,	,,	,,	Doubtful
15	,,	on Brussels	Ringed	,,
16	,,	,,	Untreated	+

The cankers produced by these inoculations were typical of those seen in nature, the infected area being slightly flattened or sunken.

The wounds made on the control trees had all healed up and callused healthily. No case has yet been observed of natural infection with *Diaporthe perniciosa* in this trial.

Observations on these cankers were made throughout the season. Fructifications of *Diaporthe perniciosa* appeared on one or two of the cankers. In no case was a tree killed by the inoculation. Though increase in size of the cankers was at first rapid, no increase in size took place after the middle of October. These results may be compared with those obtained by Miss Cayley (2).

A detailed examination of a canker was made during December, 1926. The tree taken was on a " Compatible " stock and had been inoculated with *Diaporthe* without previous ringing. At the time of examination the canker appeared externally as a flattened well-

defined elliptical area about 6 cm. long by 2 cm. broad, having spread to approximately the same distance above and below the point of inoculation (Fig. 1.).

Half of the stem was cut across 7 mm. below the point of inoculation. This disclosed a semi-circular area of discolouration in the wood underlying the canker, and a more extended blackening in the cortex (Fig. 2). Microscopic examination of transverse sections made at this level showed that the discolouration of the wood was due to gum present in the vessels : along the margin of the infected wood the gum was specially noticeable, often blocking the vessels completely. The discolouration also extended to the medullary rays in the affected area.

The cambium, phloem and cortex included in the canker were dead and disintegrating, thus bringing about the flattening of the bark. The healthy wood and phloem formed subsequent to the initiation of the canker had grown laterally so as to encroach on the area which would normally have been occupied by some of the disintegrated cells.

The important feature clearly shown by these sections was a layer of suberised cells bounding the healthy phloem and cortex, and running from the cork layer of the bark to the cambium, thus forming a complete lateral barrier for all the healthy tissue external to the wood (Fig. 3). The existence of this suberised layer together with the barrier of gum in the woody tissues undoubtedly furnishes the reason for the cessation of lateral growth of the canker.

A longitudinal section of the canker (Fig. 4) showed that the vertical spread of the infection was inhibited in precisely the same manner. A line of cork cells, interrupted only by the bast fibres, was present across the cortex and phloem, and a gum barrier had been formed in the wood both at the upper and lower ends of the canker. On the side of the infected wood towards the pith (*i.e.*, on the inside of the canker) the gum barrier was not complete although a little gumming had taken place.

Observations were made on the distribution of hyphae in the cankered region. At the limits of the dead cortical tissues no hyphae were found, but they were present in the cortex and phloem near the point of inoculation. In the wood, hyphae were most abundant in the younger vessels just inside the gum barrier. A little mycelium was present actually within the barrier, but the gum extended beyond the limits of the infected wood. A scanty mycelium was found in the older wood immediately below the point of inoculation. No bacteria were found except immediately around the open wound.

It was evident that the tree had isolated almost completely all the tissue containing mycelium. At the same time, the initial rapid growth of the canker shows that the fungus is able to act as a parasite when favoured by conditions. The results suggest that the infective powers of a parasitic strain of *Diaporthe* and the resistant powers of a healthy tree are very nearly in a state of balance. In this series of experiments the balance was first weighted in favour of the fungus by wounding the tree and inserting an amount of the fungus, which was enormously greater than the amounts which bring about natural infection. Under such conditions, the fungus made rapid progress for a time but the host, being in a vigorous condition, was able within two months to bring the attack to a standstill before the fungus had grown sufficiently to girdle the stem and so cause death of the tree. The ringing treatment was not a sufficient check (as was obvious from inspection of the trees) to favour the fungus. Some of the conditions under which the tree fails to localise the attack are dealt with below.

Field Observations on "Die-Back." *

Field observations show that trees suffering from "Die-Back" may roughly be divided into three groups :—

(1) Young trees planted up to 6 years under apparently healthy conditions.

(2) Old trees in which there is an abnormal quantity of dead wood on the younger branches and little or no growth.

(3) Trees of all ages in which the cause of death is immediately apparent.

Group I.

Undoubtedly the most puzzling problem is that presented by the first group. One of the authors has visited many plantations where young plum trees have died suddenly during the summer. The trees have been correctly planted, have a firm hold and a good root system and the anchorage is excellent. Generally they have made very good growth and appear to be in perfect condition. Examination of such a diseased tree shows that the root system, collar and much of the main stem is free from the attack of any organism. The affected portion is usually the head and upper portion of the main stem. Occasionally one side of the head, or even a single branch only shows signs of attack, but death of the whole tree quickly ensues. The trees produce leaves normally in the spring and succumb during the summer.

* Dr. Nattrass is solely responsible for the field observations recorded from this point.

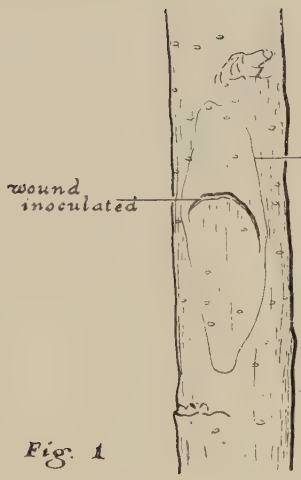


Fig. 1

EXTERNAL APPEARANCE
OF CANKER

Fig. 2  (2/3 NAT. SIZE)

HALF OF TRANSVERSE SECTION
TAKEN 7 MM. BELOW POINT OF
INOCULATION

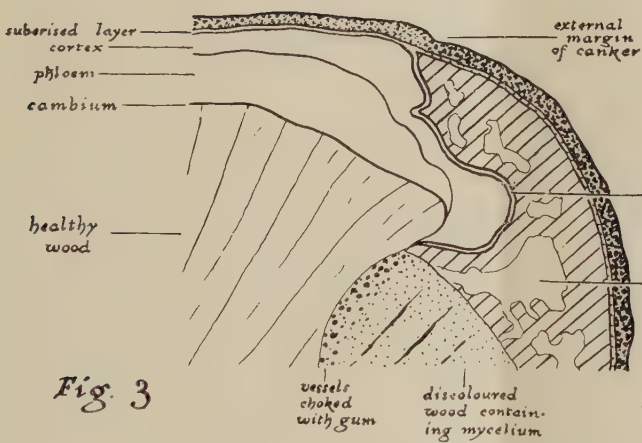
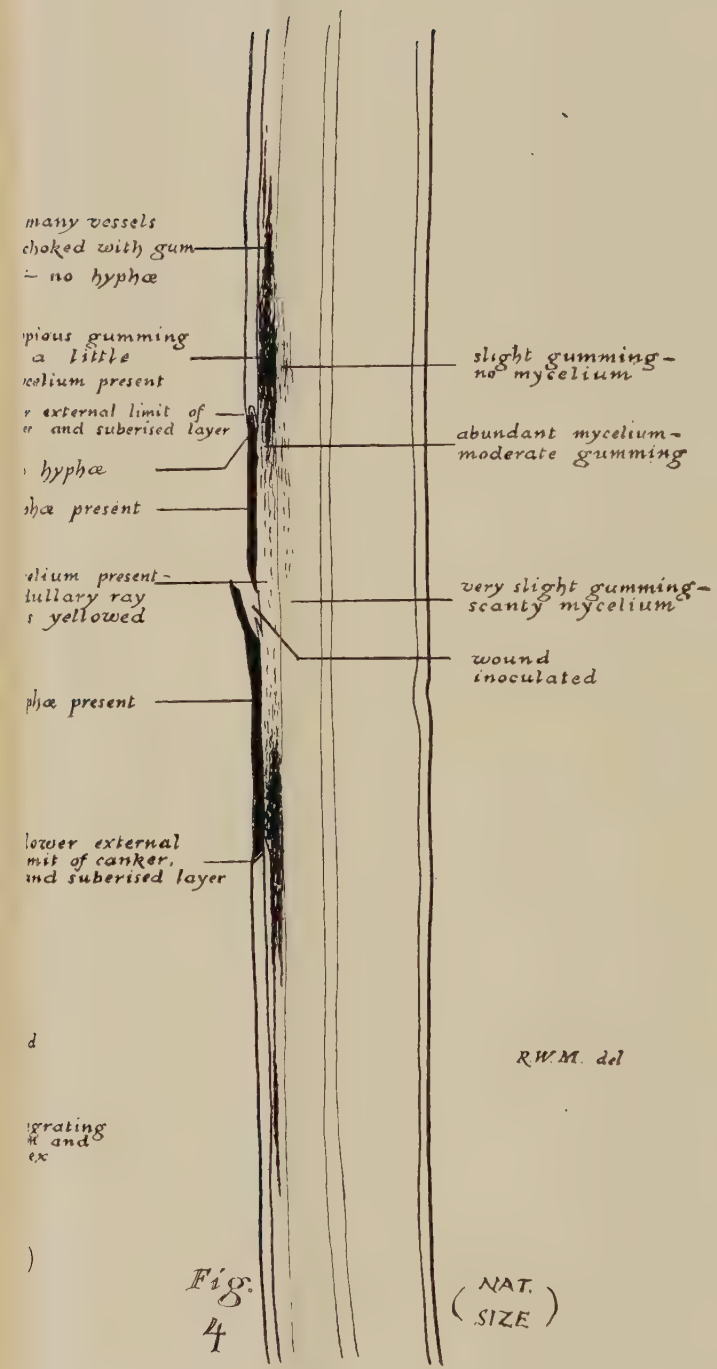


Fig. 3

PART OF FIG 2 ENLARGED



LONGITUDINAL SECTION

A number of such trees have been examined mycologically by the writers. From most trees *Diaporthe perniciosa* has been isolated at the edge of the diseased tissue. In others bacteria under conditions suggesting parasitism have been found. Since the bacterial die-back of plums is being studied at East Malling particular attention is being paid at Long Ashton to the possible parasitism of *Diaporthe perniciosa*. Several strains of *Diaporthe perniciosa* have been isolated and grown in pure culture. These show considerable differences in cultural characteristics especially in the formation of (*a*) and (*b*) spores and formation of conidia and perithecia. It is suggested that there may be parasitic and non-parasitic strains of this fungus.

Several plantations where this class of " die-back " was prevalent have been visited during the summer in company with Mr. D. A. Osmond, while engaged on the fruit soil survey of the Lower Lias. It was found that in the majority of cases the trees were growing on light soils especially where trees had made exceptionally strong vigorous growth. These soils were generally typical of the " Leaf Scorch " class of soil and the trees appeared to be in a highly nitrogenous condition. There is evidence of correlation between this form of " die-back " and soil conditions associated with " Leaf Scorch." Many young plum trees are cut hard and heavily manured before they come into bearing. It is suggested that on these soils such treatment may render them susceptible to infection by *Diaporthe perniciosa* or other parasite. It is hoped to make further study of this problem in the field with the assistance of a soil chemist. The effect of nutritional factors on the resistance of trees to infection by *Diaporthe perniciosa* will also be studied.

Diaporthe perniciosa has also been observed apparently directly infecting young wood of Victoria plum trees through the bud. These trees were young, vigorously-growing trees, heavily manured with poultry manure. Round many of the buds were small cankers 4-5 inches in length from which was isolated *Diaporthe perniciosa*. On keeping the cankered shoots for some weeks in a moist chamber, perithecia of *D. perniciosa* developed. Here again there appeared to be no contributary factor present other than an excessively "nitrogenous " condition.

Group II.

The form of " die-back " in this group appears only to affect old established trees, and is frequently seen in the Evesham district on the Lias soils. The trees make little or no growth, but have grown well in the past and there are abnormal quantities of dead

young wood. *Diaporthe perniciosa* also occurs on such wood, but, particularly on Yellow Egg plums, many branches are seen to be bearing fructifications of *Dermatea prunastri*. Whether this fungus can be parasitic or not has not been ascertained with certainty, but it undoubtedly occurs close to the margin of the diseased tissue. *Fomes pomaceus* is also abundant on such trees and is undoubtedly responsible for the death of much of the wood. The primary cause of this form of " Die-Back " has not yet been ascertained, but it may be that with certain varieties of trees in a particular soil a stage is eventually reached when the intensity of growth has become so much reduced that power of resistance to fungal attack is lost.

Group III.

The primary causes of death of the trees in this group may be waterlogging, too deep planting, chafing at the stake, rocking by wind, attacks by *Armillaria mellea* and other factors which can readily be ascertained. *Cytospora sp.* and *Diaporthe perniciosa* are almost invariably present, the latter being the direct cause of death. Dr. Briton-Jones has shown that *D. perniciosa* can become parasitic on trees which are " enfeebled on account of one or more physiological factors," and observations show that this undoubtedly holds good, more particularly in this arbitrary group. It is anticipated that large numbers of trees will fall into this group following the present excessively wet summer.

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THE OCCURRENCE OF *PHACIDIELLA DISCOLOR* POT. IN THE BRISTOL PROVINCE.

By R. M. Nattrass.

During the season 1926-1927 attention was drawn in the Report on Economic Mycology by the writer to a canker of head-worked apple trees (1). The disease takes the form of a shallow canker on the old wood, just below the graft. In extent, it varies from small areas a few inches in diameter to much larger areas involving the whole of the cut back limb. In appearance, the bark of cankered portions is a lighter brown and may in places flake off. It was observed that the most severely affected limbs were those on which the "feather" had been prematurely removed. There further appeared to be some correlation between the incidence and degree of severity of this disease and the type of soil on which the trees were growing. For instance on certain light soils where the trees were stunted and showed evidence of leaf scorch, the disease was so severe that some limbs were completely girdled and killed. On the better classes of soil no signs of the disease occurred, and even the "feather" could be removed with impunity.

Growing on the surface of these cankers occured numbers of small olive green pycnidial fructifications which stand out from the surface of the substratum in a characteristic manner. These fructifications contain oval hyaline conidia 10-14μ by 7-8μ and were identified by Miss Wakefield as *Fuckelia conspicua* Marshal, the conidial stage of the discomycetous fungus *Phacidiella discolor* Pot., which had not previously been recorded in this country. The conidial stage of this fungus had been observed and worked on by Southee and Brooks (2) in the Cambridge district, in which paper the fructifications are figured.

During the present season the disease has been observed on pear trees in Worcestershire. The plantation concerned consisted of mature 15-20 year old trees of the variety "Red Robin." On these trees all stages of the "Bark Canker" could be seen from small irregular discoloured areas on the bark to definite cankers many inches in length (Fig. 1). Occasionally such cankers cause the death of lateral branches by girdling them at the base.

On the younger cankers occurred the conidial fructifications of *Fuckelia conspicua* Marchal which were identical with those observed on apple trees the previous season. On the older cankers were abundant apothecia which agreed with the description given by Potebnia of the fungus named by him *Phacidiella discolor* Pot. (3). Mono-spore cultures made from ascospores and conidia were identical, and cultures from either source on malt extract agar, produced pycnidia containing conidia similar to those found in nature, thus confirming the relationship between these two forms.

The fungus does not appear to attack healthy trees. In the first instance the attacks on apple trees were confined to trees headed back, and then only those growing under adverse soil conditions. On the pear trees the fungus was only observed on the one variety "Red Robin." These trees had borne heavy crops for a number of years, and it is possible that they had reached the limit of productive growth on that particular soil. Trees in such a condition would tend to become susceptible to fungi which are normally weak parasites. Inoculation experiments carried out with pure cultures, on malt extract agar, on healthy young trees, failed to produce infection.

The fungus does not appear to be a virulent parasite on trees. It has not yet been observed by the writer on fruit, though it is known to occur on the Continent. (4) and (5).

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TEXT FIGURE.

1. Canker caused by *Phacidiella discolor* on branch of pear—"Red Robin." Nat. Size.

FIGURE I.

Canker on Branch of " Red Robin " pear caused by *Phacidiella discolor*. Nat. Size.

FURTHER EXPERIMENTS ON THE CONTROL OF THE AMERICAN GOOSEBERRY MILDEW, SEASON 1927.

By R. M. Nattrass.

These experiments are a continuation of those carried out by the writer during 1925 (1) and 1926 (2). It is considered that the relative values of the two types of spray, *i.e.*, the hitting type such as Ammonium Polysulphide and Soft Soap, Soda and Soft Soap, etc., and a " protective " spray such as Bordeaux and Burgundy Mixture have already been demonstrated. In the 1927 trials powdered sulphur and a proprietary " Colloidal " Sulphur were tested against the standard Ammonium Polysulphide.

One series of trials (A) was carried out by the Adviser at Cheltenham, and another series (B) was carried out in collaboration with the writer by Mr. H. T. Horsfield at Knowle Hill, Evesham.

Series (A).

The Plots.

The plots consisted of well grown " Whinham's Industry " bushes in series of double rows, each series being 25 feet apart and containing 48 bushes. Two series were sprayed with " *Colloidal Sulphur* " and one series with *Ammonium Polysulphide* once only. Another series was treated with *Flowers of Sulphur*, twice. The control plot consisted of the eight central bushes in each series forming a strip running through the centre of the plot.

Sprays.

The two following spray fluids and powder were used :—

A. Ammonium Polysulphide and Soft Soap.

Ammonium Polysulphide ..	½ gall.
Soft soap	5 lbs.
Water to make up to	100 galls.

B. Colloidal Sulphur (liquid) and Soft Soap.

Colloidal Sulphur	5 lbs.
Soft Soap	5 lbs.
Water to make up to	100 galls.

C. Flowers of Sulphur.

The first application of all three materials was made on April 27th. A furthur application of the Flowers of Sulphur was made on May 26th.

Results.

The fruit was picked on July 4th and 5th, sorted into clean and mildewed berries and weighed.

The following table gives the weight of clean and mildewed berries from each plot.

TABLE I.

Fungicide.	No. of times applied.	Date.	Crop weight in lbs.		% weight of mildewed berries.
			Clean.	Mildewed.	
Ammonium polysulphide	Once	April 27th	153	33	17.6
Colloidal Sulphur	Once	April 27th	448	51	10.2
Flowers of Sulphur	Twice	April 27th May 26th	210	13	5.8
Control	No spray		23	52	69.0

It will be seen from the very heavy infestation of the control plot that the conditions were very favourable to the disease. Two applications of *Flowers of Sulphur* reduced the amount of mildew from 69% to 5.8%. This, under the circumstances, can be considered a good commercial control. The *Ammonium Polysulphide* applied once gave a reduction to only 17.6% of mildewed berries. This result once again emphasises the fact that a " hitting " spray of this type must be applied more than once unless the weather conditions are very unfavourable to the disease. Promising results were obtained by the single application of the *Colloidal Sulphur*. This spray fluid appears to act as a " protective " spray rather than a " hitting " spray. It remains on the foliage for a considerable time, and in this experiment no signs of scorching were observed.

SERIES (B).

In this trial the following materials were used :—

A. Amberene .. .. .. 2 galls.
Soft soap .. .. .. 5 lbs.
Water to make .. .. 100 galls.

B. Colloidal Sulphur .. .. 4 lbs.
Soft soap .. .. .. 5 lbs.
Water to make .. .. 100 galls.

C. Flowers of Sulphur.

D. Ground Sulphur.

E. Green Sulphur.

Two applications were given, the first on April 13th and the second on May 16.

Results.

The crop was picked green and treated as in trial (A).

The following table gives the weight of clean and mildewed berries from each plot.

TABLE II.

Fungicide.	Date.	Crop weight in lbs.		% weight of mildewed berries.
		Clean.	Mildewed.	
Colloidal Sulphur	April 13th May 10th	225	15.5	6.7
Amberene	ditto	333	23.0	6.4
Flowers of Sulphur ..	ditto	124	4.0	3.1
Ground Sulphur	ditto	193	2.0	1.0
Green Sulphur	ditto	151	2.5	1.6
Control	no spray	96	115.0	54.5

It will be seen from the above figures that excellent control was obtained by the three forms of powdered sulphur. Under the conditions of this experiment the differences between the three figures 3.1%, 1% and 1.6% are not considered to be significant. It appears that any one of the three forms will control the mildew.

REPORT ON BUNT PREVENTION TRIALS, 1927.

By R. M. Nattrass.

At the request of the Ministry of Agriculture trials were carried out on the prevention of Bunt of Wheat. Seed of the variety *Little Joss* from the 1926 crop, artificially contaminated with Bunt spores, and treated with various fungicides was received from the Pathological Laboratory for sowing.

Each series consisted of four plots treated as follows :—

(1) Formaldehyde, 40% solution.	1 in 320.
(2) Copper Sulphate solution.	2.5%.
(3) Copper Carbonate Powder.	2 ozs. per bushel.
(4) Untreated.	

The plots in each series consisted of eight drills, 25 feet in length, sown at the rate of 1 oz. of seed to 25 feet of drill.

The plots were laid down as part of a field of wheat and were given the normal after-cultivation as part of the whole field.

At harvest time each head was carefully examined, and the numbers of clean and bunted heads in each plot recorded.

The County Agricultural Organiser for Wiltshire kindly arranged for three series to be laid down in that County.

The Adviser is indebted to Messrs. Tomlinson and Thomas, Agricultural Instructors for Wiltshire, for assistance in sowing the plots, and to Mr. R. W. Marsh for help in recording the results.

No. 1. Kingston Deverill, Wilts.

The plot was sown on November 4th on the furrow immediately after ploughing.

Previous crop : turnips fed on land by sheep. The condition of the soil at sowing time was ideal.

The plot was visited on March 24th, when it was observed that the best plant occurred on the untreated plot. Of the treated plots the copper carbonate was best. No difference could be seen between the copper sulphate and formalin plots.

Records of the plot were taken on August 12th.

	Total number of heads.	Number of Bunted Heads.	% Bunted Heads.
Control	2290	415	18.11
Copper Sulphate ..	2508	5	0.19
Copper Carbonate ..	2130	9	0.42
Formaldehyde ..	2734	0	.0

No. 2. Burderop, Wilts.

The plot was sown on October 27th in a fairly heavy soil after beans. Previous to sowing the field had been ploughed and dragged. The condition of the land at sowing time was ideal.

The plot was visited on March 23rd, when it was observed that the formalin plot appeared to have lain wet during the winter. The best plant was on the untreated plot. The plant on the formalin plot was as thick as the copper sulphate plot, but not quite so forward. There was no noticeable difference between the copper sulphate plot and the copper carbonate plot.

Records of the plot were taken on August 16th.

	Total number of heads.	Number of Bunted Heads.	% of Bunted Heads.
Control	2860	286	10.0
Copper Carbonate ..	2664	24	.09
Copper Sulphate ..	2552	0	0
Formalin	2126	0	0

No. 3. Great Chalfield, Melksham, Wilts.

The plot was sown on October 27th, on pressed furrow, after three years ley. Sowing conditions were ideal.

The plot was visited on March 23rd, when all the plots were looking remarkably well. The thickest plant occurred on the untreated plot, and was much too thick for ordinary farm practice. The copper carbonate plot was slightly thinner than the formalin plot, but there was very little difference between the two. The thinnest plant occurred on the copper sulphate plot. This was a sufficiently good plant for all ordinary purposes.

Records of the plot were taken on August 17th.

	Total number of heads.	Number of Bunted Heads.	% of Bunted Heads.
Control	2164	368	17.0
Copper Carbonate ..	2646	19	0.73
Copper Sulphate ..	2686	4	0.15
Formalin	2723	21	0.76

It will be seen from these three trials that the preventive dressings used do control bunt in wheat to a considerable extent. Under the conditions of this experiment it is impossible to differentiate between the relative merits of the three dressings. It would appear, however, that the copper carbonate is not quite so efficient as the copper sulphate and the formaldehyde treatment.

It must be understood that these trials were carried out under field and not experimental plot conditions, each series being a part of a commercially grown field of wheat.

Under these conditions it was not possible adequately to protect the plots from the depredation of birds.

ONION IMMUNITY TRIALS—1927.

By R. M. Nattrass.

A further trial on the immunity of varieties of onion to the White Rot Disease *Sclerotium cepivorum* was carried out in collaboration with Mr. E. Holmes-Smith, Adviser in Agricultural Botany, University of Manchester.

The seed was sown on infected land during the first two weeks in August, 1926. The onions were lifted on June 3rd, 1927.

The seed was supplied by Mr. E. Holmes-Smith.

The table below gives the number of clean and diseased bulbs of each variety.

Variety.	Sound.	Diseased.	%
Italian Tripoli	325	37	11.4
Lemon Rocco	485	21	4.3
Globe Tripoli	493	69	13.9
White Welsh	1158	336	29.0
White Globe	796	69	8.6
White Lisbon	475	119	25.0

CIDER-MAKING TRIALS FOR THE SEASON 1926—1927.

By O. Grove.

For the third year in succession the cider apple crop was below average. The quality of the juices was good, the average specific gravity of all the juices made into cider at Long Ashton being 1.0532.

The Cider Competitions.

The special competitions which were started last year were continued, and 75 entries of fruit were received. The competitions were carried out on the same lines as last year, and a class for perry pears introduced. In each case 15 cwts. of fruit were used, the fruit kept until judged to be fit for milling, and the subsequent treatment the same in each class. The ciders were filtered when the juice had fermented down to the following specific gravities :— Class I 1.028, Classes II and VI 1.030, Classes III, IV and V 1.025. Details of the entries will be found in Table 1.

The competition was open to growers residing in the counties of Devon, Dorset, Gloucester, Hereford, Monmouth, Somerset and Worcester.

The ciders were judged on the 20th of April, 1927, by Messrs. Wm. D. McCreath, North Petherton, Somerset ; John W. Pullin, Compton Greenfield, Gloucester ; and A. L. Sadler, Tiverton, Devon. They reported as follows :—

Report of Judges on the Long Ashton Cider Competitions 1926-27.

The ciders in these competitions were judged by us on Wednesday, April 20th, 1927, to enable the awards to be announced on the occasion of the Annual Tasting Day on Thursday, May 5th. As pointed out by the Judges in the corresponding competition last year, this early date for judging involves the drawback of the ciders being still comparatively immature at the time of judging, and allowance for this fact has had to be made in considering the awards.

The entries were divided into six classes five for cider and one for perry. The five classes for cider were as in last year's Competitions, viz. :—

Class I for the Kingston Black variety alone.
„ II „ single varieties of the sharp class.
„ III „ „ „ „ sweet „
„ IV „ „ „ „ bittersweet class.
„ V „ mixed varieties of apples, selected and blended by the individual competitors themselves in proportions judged by them to constitute a satisfactory blend.

The class for perry, Class VI, was for any single variety of perry pear.

In Class I, the ciders generally were of a useful order, although in no case quite reaching the best Kingston Black standard. The acidity on the whole was more marked than is customary for the variety, but the bitter character was not so pronounced as it is in some seasons. The body was fair throughout and the colour on the pale side for the variety. The entries gaining awards were characterised by their relative softness.

Class II, consisting of the "sharp" varieties, was with one or two exceptions a class of clean useful ciders. The prizewinners and the other ciders receiving mention were particularly noteworthy, and it was not easy to decide the order of merit.

In the "sweet" class, Class III, the ciders sorted themselves into two obvious groups, those gaining awards being definitely of a higher grade than the others. The standard of the superior group was distinctly high.

The "bittersweet" class, Class IV, proved an extremely difficult one to judge. The ciders as a whole were good and differed chiefly in degree of bitterness. We recognise that there will be undoubtedly a considerable variety of opinion as to the relative merits of at least one-half of the ciders in this class.

Class V for "blends" was last year of a disappointing character. On this occasion the average was really good, and several of the entries were of distinctly high quality. The settlement of the final order was not an easy matter.

The perry class, Class VI, did not contain any outstandingly good entry. Most of the perries showed a marked astringent character,

and the quality generally was, if anything, below rather than above average.

In conclusion, we desire to express our satisfaction at the general condition of the samples and the obvious evidence that the treatment in all cases had been as uniform as possible, thus giving all entries an equal chance. The number of entries was surprisingly high considering the limited crop of fruit and augurs well for the future success of this Competition Scheme.

Sgd. Wm. D. McCreath.
,, John W. Pulhin.
,, A. L. Sadler.

Judges.

TABLE I.

COMPETITION VARIETIES.

No.	Name of Variety.	Name of Grower.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation at 25°C	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity. May, 1927.	District where grown.
	CLASS 1.—Kingston Blacks—										
1	Kingston Black	H. Knight	4/11/26	1.067	0.77	0.19	8.4	26/11/26	1.028	1.024	Huntley, Glos.
2	,, ,,	J. A. H. Hurditch	18/10/26	1.061	0.74	0.20	4.4	11/12/26	1.028	1.027	Yatton, Som.
3	,, ,,	W. Wyatt	20/10/26	1.063	0.80	0.17	8.0	22/11/26	1.028	1.027	Kingweston, Som.
4	,, ,,	R. J. Denning	4/11/26	1.056	0.62	0.18	4.6	18/12/26	1.028	1.027	Ilminster, Som.
5	,, ,,	H. E. Dabinett	5/11/26	1.060	0.62	0.18	3.7	7/1/27	1.028	1.027	Somerton, Som.
6	,, ,,	E. W. Dabinett	4/11/26	1.066	0.76	0.20	5.8	23/12/26	1.028	1.028	Kingweston, Som.
7	,, ,,	H. C. Jennings	4/11/26	1.066	0.67	0.17	5.6	7/1/27	1.028	1.028	Shapwick, Som.
8	,, ,,	A. E. Hill	4/11/26	1.061	0.69	0.17	5.0	12/1/27	1.028	1.028	Ledbury, Her.
9	,, ,,	W. Hunt	4/11/26	1.056	0.60	0.18	5.0	12/1/27	1.028	1.028	Easton-in-Gordano, Som.
10	,, ,,	R. E. Turner	4/11/26	1.067	0.69	0.20	6.2	30/12/26	1.028	1.028	Dymock, Glos.
11	,, ,,	F. Hill	7/11/26	1.070	0.70	0.24	5.1	16/2/27	1.028	1.028	Kittisford, Som.
12	,, ,,	H. G. Jones	9/11/26	1.062	0.64	0.18	6.0	30/12/26	1.028	1.028	Blakemere, Her.
	CLASS 2.—Sharp Varieties—										
13	Perthyres	G. Breakwell	25 10 26	1.057	0.49	0.14	8.0	15 11,26	1.030	1.021	Rockfield, Mon.
14	Bran Rose	S. P. Taylor	7/11/26	1.060	0.73	0.29	10.6	22/11/26	1.030	1.022	Dymock, Glos.
15	Fair Maid of Devon	F. Hill	22/10/26	1.055	1.09	0.12	6.0	19/11/26	1.030	1.028	Kittisford, Som.
16	Frederick	G. Breakwell	25/10/26	1.051	1.17	0.07	8.1	11/11/26	1.030	1.028	Rockfield, Mon.
17	Dymock Red	R. E. Turner	18/10/26	1.055	0.68	0.26	5.7	26/11/26	1.030	1.029	Dymock, Glos.
18	Stoke Red Stripes	H. H. Sealey	1/11/26	1.053	0.65	0.26	6.5	26/11/26	1.030	1.029	Rodney Stoke, Som.
19	Lambrook Pippin	R. J. Denning	20/11/26	1.050	0.72	0.24	5 0	21/12/26	1 030	1.029	Ilminster, Som.
20	Hartisman	W Hunt	24/11/26	1.050	0.99	0.13	5.5	27/12/26	1.030	1.029	Easton-in-Gordano, Som.
21	Breakwell's Seedling	G. Breakwell	8/10/26	1.034	0.65	0.14	4.0	13/10/26	1.030	1.030	Rockfield, Mon.
22	Buttery Door	H. E. R. Warren	18/10/26	1.046	0.77	0.14	6.6	6/11,26	1.030	1.030	Netherbury, Dorset.
23	Frederick	S. S. W. Mullins	22/10/26	1.052	1.15	0.09	7.0	26/11/26	1.030	1.030	Raglan, Mon.
24	White Spice	W. Hunt	5/11/26	1.048	0.71	0.11	3.2	18/12/26	1.030	1.030	Easton-in-Gordano, Som
25	Gatcombe	W. Butler	15/11/26	1.053	0.70	0.08	3.8	27/12 26	1.030	1.030	Long Ashton, Som.
26	Lambrook Pippin	E. W. Dabinett	20 11,26	1.067	0.86	0.39	4.7	10/1/27	1.030	1.030	Kingweston, Som.
27	Golden Ball	J. Bowditch	24/11/26	1.045	0.63	0.15	3.2	30/12/26	1.030	1.030	Stoke Abbott, Dorset.

	CLASS 3.—Sweet Varieties—										
28	Bunch Jersey ..	E. W. Dabinett..	22/10/26	1.046	0.32	0.08	9.7	8/11/26	1.025	1.017	Kingweston, Som.
29	Green Bittersweet	„ „ ..	22/10/26	1.052	0.26	0.15	6.6	15/11/26	1.025	1.019	„ „
30	Bunch Jersey ..	W. Wyatt ..	20/10/26	1.048	0.33	0.09	8.0	12/11/26	1.025	1.020	„ „
31	Woodbine	R. J. Denning ..	7/11/26	1.053	0.32	0.15	11.0	24/11/26	1.025	1.023	Ilminster, Som.
32	Spotted White ..	W. Wyatt ..	18/10/26	1.049	0.24	0.14	9.0	8/11/26	1.025	1.024	Kingweston, Som.
33	Berkeley Pippin ..	V. J. Davis ..	1/11/26	1.058	0.29	0.15	7.5	28/11/26	1.025	1.025	Berkeley, Glos.
34	Sweet Alford ..	H. Lee	25/10/26	1.051	0.21	0.13	3.0	22/12/26	1.025	1.025	Broadclyst, Devon.
35	Woodbine	F. Hill	7/11/26	1.060	0.28	0.16	4.8	28/12/26	1.025	1.025	Kittisford, Som.
	CLASS 4.—Bittersweet Varieties—										
36	Dabinett	G. H. Sawtell ..	18/10/26	1.047	0.29	0.21	6.6	15/11/26	1.025	1.024	Kingweston, Som.
37	Royal Wilding ..	F. Pole	20/10/26	1.058	0.24	0.21	6.4	17/11/26	1.025	1.024	Holmer, Her.
38	Dove	H. E. Dabinett ..	5/11/26	1.047	0.29	0.25	3.7	7/1/27	1.025	1.024	Somerton, Som.
39	Dabinett	W. B. Gent ..	5/11/26	1.054	0.22	0.21	5.2	14/12/26	1.025	1.024	Muchelney, Som.
40	Tremayne Bitter ..	H. Lee	25/10/26	1.057	0.33	0.30	5.0	31/12/26	1.025	1.025	Broadclyst, Devon.
41	Red Jersey ..	R. J. Denning ..	1/11/26	1.049	0.25	0.30	3.2	25/12/26	1.025	1.025	Ilminster, Som.
42	Dabinett	R. A. Clarke ..	5/11/26	1.054	0.27	0.32	6.0	23/12/26	1.025	1.025	Chiselborough, Som.
43	Dabinett	J. H. Symes ..	9/11/26	1.053	0.19	0.20	4.6	12/1/27	1.025	1.025	Martock, Som.
44	Dabinett	Scott and Gent ..	7/11/26	1.055	0.21	0.24	6.3	28/12/26	1.025	1.025	East Lambrook, Som.
45	Belle Norman ..	W. R. Williams ..	25/11/26	1.052	0.20	0.27	3.6	13/1/27	1.025	1.025	Hampton Bishop, Her.
46	Strawberry Norman	„ „ ..	25/11/26	1.051	0.34	0.32	4.2	11/1/27	1.025	1.025	„ „ „
47	Cummy Norman ..	„ „ ..	25/11/26	1.046	0.34	0.29	3.6	18/12/26	1.025	1.025	„ „ „
	CLASS 5.—Mixed Varieties—										
48	Unnamed Local Varieties	Clinch & Goddard	15/11/26	1.051	0.44	0.29	8.3	6/12/26	1.025	1.022	Upton-on-Severn, Wor.
49	Striped Norman, Jerseys, Local Varieties	G. H. Sawtell ..	18/10/26	1.053	0.43	0.15	8.6	10/11/26	1.025	1.023	Kingweston, Som.
50	Maynards Bittersweet, Cap of Liberty, Pound Apple, Dorchester Red Streak	W. Maynard ..	1/11/26	1.055	0.47	0.19	7.4	22/11/26	1.025	1.023	Martock, Som.
51	Unnamed Local Varieties ..	Scott and Gent ..	5/11/26	1.051	0.39	0.24	5.5	14/12/26	1.025	1.023	East Lambrook, Som.

TABLE I.—*continued.*

COMPETITION VARIETIES.

No.	Name of Variety.	Name of Grower.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation at 25°C	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity. May, 1927.	District where grown.
CLASS 5.—MIXED VARIETIES—*continued.*											
52	Woodbine, Hangdown, Sheep's Nose, Taunton Bitter	F. Hill	22/10/26	0.057	0.63	0.14	7.2	22/11/26	1.025	1.024	Kittisford, Som.
53	Unnamed Local Varieties	.. R. E. Turner ..	1/11/26	1.053	0.55	0.21	8.2	19/11/26	1.025	1.024	Dymock, Glos.
54	Broadleaves, Cap of Liberty, Woodbine, Red Jersey	R. J. Denning ..	1/11/26	1.051	0.46	0.19	6.7	27/11/26	1.025	1.024	Ilminster, Som.
55	Woodbine, Fair Maid, Improved Bittersweet, Hangdown	S. Cursons ..	1/11/26	1.061	0.29	0.14	6.0	7/12/26	1.025	1.024	Dunsford, Devon.
56	Sour Hangdown, Sweet Blenheim, Loyal Drain, Truckle, Dove	H. C. Jennings ..	25/10/26	1.050	0.30	0.16	4.7	30/11/26	1.025	1.025	Shapwick, Som.
57	Brown's Apple, Bickington Grey, Pocket Apple, Kingston Bitter	J. Hoare	1/11/26	1.056	0.56	0.16	5.6	14/12/26	1.025	1.025	Staverton, Devon.
58	Dabinett, Cap of Liberty, Profit	.. R. A. Clarke ..	1/11/26	1.053	0.47	0.22	6.7	1/12/26	1.025	1.025	Chiselborough, Som.

59	Pound Apple, Ponsford, Fair Maid, Sweet Coppin, Sweet Alford	H. Lee	25/10/26	1.054	0.57	0.15	5.6	1/12/26	1.025	1.025	Broadclyst, Devon.
60	Loyal Drain, Horner, Red Streak	H. E. Dabinett ..	5/11/26	1.048	0.59	0.34	5.7	14/12/26	1.025	1.025	Somerton, Som.
61	Unnamed Local Varieties	S. S W. Mullins	5/11/26	1.053	0.44	0.21	5.7	10/12/26	1.025	1.025	Raglan, Mon.
62	White Norman, Strawberry Norman, Hagloe Crab, Bastard Foxwhelp, Red Streak	H. G. Jones ..	9/11/26	1.056	0.41	0.24	5.4	16/2/27	1.025	1.025	Blakemere, Her.
63	Horner, Sharp Apple, Dabinett, Never Blight	J. H. Symes ..	9/11/26	1.054	0.44	0.20	3.8	21/1/27	1.025	1.025	Martock, Som.
64	6 Unnamed Local Varieties	B. Pearce ..	15/11/26	1.048	0.76	0.24	4.8	24/12/26	1.025	1.025	Winford, Som.
65	Unnamed Local Varieties	J. Bowditch ..	24/11/26	1.060	0.51	0.14	6.7	22/12/26	1.025	1.025	Stoke Abbott, Dorset.
66	Unnamed Local Varieties	J. Bowditch ..	24/11/26	1.049	0.52	0.14	3.7	29/12/26	1.025	1.025	Stoke Abbott, Dorset.
67	Sams Crab and White Norman	W. R. Williams ..	25/11/26	1.054	0.27	0.24	3.6	12/1/27	1.025	1.025	Hampton Bishop, Her.
	CLASS 6.—PERRIES—										
68	Longdon	Clinch & Goddard	15/11/26	1.045	1.06	0.15	5.0	18/12/26	1.030	1.028	Upton-on-Severn, Wor.
69	Taynton Squash	H. Knight ..	13/10/26	1.051	0.41	0.08	6.2	13/11/26	1.030	1.030	Huntley, Glos.
70	Ingstone	H. Knight ..	25/10/26	1.050	0.43	0.16	5.2	30/11/26	1.030	1.030	„ „
71	Blakeney Red	R. E. Turner ..	18/10/26	1.049	0.55	0.13	2.8	21/12/26	1.030	1.030	Dymock, Glos.
72	Huffcap	R. E. Turner ..	18/10/26	1.055	0.44	0.33	2.5	27/1/27	1.030	1.030	„ „
73	Oldfield	F. Pole	20/10/26	1.063	0.86	0.25	4.2	16/2/27	1.030	1.030	Holmer, Her.
74	Blakeney Red	S. S. W. Mullins	22/10/26	1.046	0.47	0.09	6.6	22/11/26	1.030	1.030	Raglan, Mon.
75	Butt	H. A. Lane ..	15/11/26	1.057	0.96	0.43	3.1	23/2/27	1.030	1.030	Chaceley, Wor.

Table II.

Competition Ciders, 1926-27.

JUDGES AWARDS.

	*No.**	
Class 1.		Kingston Black. (12 *Entries*).
First Prize	11	F. Hill, Kittisford, Somerset.
Second Prize	4	R. J. Denning, Ilminster, Somerset.
Third Prize	5	H. E. Dabinett, Somerton, Somerset.
Reserve	10	R. E. Turner, Dymock, Gloucester.
Class 2.		Sharp Varieties. (15 *Entries*).
First Prize	18	H. H. Sealey, Rodney Stoke, Somerset.
Second Prize	17	R. E. Turner, Dymock, Gloucester.
Third Prize	27	J. Bowditch, Stoke Abbott, Dorset.
Reserve	20	W. Hunt, Easton-in-Gordano, Somerset.
Highly Commended	19	R. J. Denning, Ilminster, Somerset.
Class 3.		Sweet Varieties. (8 *Entries*).
First Prize	34	H. Lee, Broadclyst, Devon.
Second Prize	33	V. J. Davis, Berkeley, Gloucester.
Reserve	35	F. Hill, Kittisford, Somerset.
Highly Commended	31	R. J. Denning, Ilminster, Somerset.
Class 4.		Bittersweet Varieties. (12 *Entries*).
First Prize	45	W. R. Williams, Hampton Bishop, Hereford.
Second Prize	37	F. Pole, Holmer, Hereford.
Third Prize	43	J. H. Symes, Martock, Somerset.
Reserve	41	R. J. Denning, Ilminster, Somerset.
Highly Commended	44	Scott and Gent, East Lambrook, Somerset.
Commended	38	H. E. Dabinett, Somerton, Somerset.
Class 5.		Mixed Varieties. (20 *Entries*).
First Prize	62	H. G. Jones, Blackmere, Hereford.
Second Prize	57	J. Hoare, Staverton, Devon.
Third Prize	55	S. Cursons, Dunsford, Devon.
Reserve	56	H. C. Jennings, Shapwick, Somerset.
Highly Commended	63	J. H. Symes, Martock, Somerset.
Commended	50	W. Maynard, Martock, Somerset.
Commended	59	H. Lee, Broadclyst, Devon.
Commended	67	W. R. Williams, Hampton Bishop, Hereford.
Class 6.		Perries. (8 *Entries*).
First Prize	74	S. W. Mullins, Raglan, Monmouth.
Second Prize	69	H. Knight, Huntley, Gloucester.
Reserve	73	F. Pole, Holmer, Hereford.
Highly Commended	71	R. E. Turner, Dymock, Gloucester.

* The numbers stated refer to the ciders described under the corresponding numbers in Table I.

Some of the entries deserve special mention, as the varieties had not been tried previously for cider-making at Long Ashton. In Class II (sharp varieties), No. 18, Stoke Red Stripes produced a cider of very high merit, which was awarded first prize in the competition. The orchard where this apple grows has been visited. As the trees are exceptionally good growers and croppers, this variety promises to be worthy of a place amongst the best sharp cider apples. No. 20, Hartisman, produced a good clean sharp cider. No. 21, Breakwell's Seedling, is an early apple without

any merit for cider. No. 22, Buttery Door, gave a fair cider with an aromatic flavour, but the rate of fermentation is too high. No. 24, White Spice, produced a sharp cider without much character. No. 27, Golden Ball, seems a very useful cider apple, the resulting cider being good with a clean brisk and pleasant flavour.

In Class III (sweet varieties), Nos. 28 and 30, Bunch Jersey, from the same district, gave very fair sweet ciders. The same cannot be said of No. 29, Green Bittersweet, which was rather inferior. No. 32, Spotted White, gave a sweet cider of indifferent value. No. 33, Berkeley Pippin, proved to be a very useful sweet cider apple, but the rate of fermentation of the juice is on the high side.

In Class IV (bittersweet varieties) the two first, Dabinett and Royal Wilding, are well known as two of the best apples in the bittersweet group. No. 38, Dove, produced a very fair cider without much character. No. 40, Tremayne Bitter, was rather coarse and too bitter in flavour to be used unblended. No. 41, Red Jersey, was also on the bitter side, but otherwise a very fair cider. No. 45, Belle Norman, gave a very good clean-flavoured cider with a nice bouquet.

With regard to Class V (mixed varieties), it may be said that on the whole the blends of apples selected for individual entries were very well chosen to produce a cider in which the constituents were well balanced. A few of them, as for instance No. 64, were too sharp in flavour and would have been better if a smaller proportion of sharp apples had been used; but in most cases the acid and tannin figures were very near those found in the best types of cider.

In Class VI (Perries) No. 68 was much too sharp with an acidity of over one per cent.; otherwise the flavour was quite good. No. 70, Ingstone, produced a fair perry without much aroma. The other varieties, which have been tried on former occasions, were on the whole not up to the usual standard.

Single Variety Trials.

Besides the competitions some other varieties were sent in for trial (Table III). Of these the following have not been tried before. No. 77, Kings Favourite, produced a very sharp cider with a good colour and a clean, sharp flavour; this apple is too sharp for use alone, but appears very useful for blending with sweet and bittersweet varieties. No. 78, Browns Apple, is a sharp apple of very good quality; the cider had a very nice flavour and a rich colour and could be used alone, although the acidity is rather high. No. 81, Red Wilding, gave a bittersweet cider of no great distinction.

TABLE III.

MISCELLANEOUS SINGLE VARIETY CIDERS.

In each case the pomace was pressed immediately after milling, and the juice allowed to ferment naturally in cask until the specific gravity had dropped to 1.025—1.035 in the average case, when the liquor was filtered.

No.	Name of Variety.	District where grown.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation at 25°C.	Date of Filtering.	Specific Gravity May, 1927.	Remarks.
76	Kingston Black	Elmore, Glos.	1/11/26	1.061	0.64	0.16	7.0	16/12/26	1.029	Sharp Variety.
77	Kings Favourite	Melplash, Dorset	15/11/26	1.053	0.96	0.12	3.7	13/12/26	1.030	„ „
78	Browns Apple	Staverton, Devon	1/11/26	1.054	0.72	0.12	3.2	6/12/26	1.034	„ „
79	Medaille d'Or	Byford, Her.	15/10/26	1.048	0.23	0.35	11.0	29/10/26	1.021	Bittersweet Variety.
80	Cherry Norman	Moorhampton, Her.	14/10/26	1.050	0.27	0.25	6.0	17/11/26	1.026	„ „
81	Red Wilding	„ „	15/10/26	1.054	0.31	0.26	5.0	27/11/26	1.026	„ „

Pure Yeast Fermentation Trials.

Experiments with the fermentation of pasteurised juice with pure yeasts were continued. The juice was passed through the "Salvator" pasteuriser, where it reaches a maximum temperature of 160° F., and afterwards inoculated with a culture of pure yeast. Ten hogsheads were filled with the pasteurised juice, and a further cask with the natural, unpasteurised juice as a control. The yeasts used were the following, the name in brackets indicating the cider or wine from which the yeast has originally been isolated :

No. 6 (Kingston Black, 1912).
No. 27 (Johannesberg).
No. 32 (Steinberg).
No. 37 (Riesling).
No. 41 (Danish Cider).
No. 42 (Port).
No. 43 (Petro Zimenez).
No. 44 (Champagne).
No. 45 (Champagne).
No. 46 (Port).

All the samples were filtered when the specific gravity had fallen to approximately 1.025. The filtering dates in Table IV show how much slower the fermentation proceeded in the pasteurised samples than in the naturally fermented control. On different occasions during the summer the "pure yeast" samples were compared with the control, and it was found that the flavours varied appreciably. Whereas the two first, namely Nos. 83 and 84, were judged to be a little inferior to the control, the rest of the samples were preferred to the control by most judges, Nos. 90 and 92 especially being considered distinctly superior in flavour and character.

TABLE IV.

EXPERIMENTS WITH PASTEURISED CIDERS.

Ciders made from juices pasteurised at 160° Fah. immediately after milling and fermented with pure yeasts.

No	Name of Variety.	District where grown.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation at 25°C.	Date of Filtering.	Specific Gravity May, 1927.	Remarks.
82	Mixed Apples ..	Ledbury	7/12/26	1.046	0.36	0.21	3.0	21/1/27	1.024	Control (fermented naturally)
83	„ „ ..	„	„	„	„	„	„	9/3/27	1.024	Fermented with yeast No. 6
84	„ „ ..	„	„	„	„	„	„	9/3/27	1.025	„ „ „ „ 27
85	„ „ ..	„	„	„	„	„	„	5/3/27	1.024	„ „ „ „ 32
86	„ „ ..	„	„	„	„	„	„	19/3/27	1.025	„ „ „ „ 37
87	„ „ ..	„	„	„	„	„	„	21/3/27	1.025	„ „ „ „ 41
88	„ „ ..	„	„	„	„	„	„	21/3/27	1.024	„ „ „ „ 42
89	„ „ ..	„	„	„	„	„	„	11/3/27	1.024	„ „ „ „ 43
90	„ „ ..	„	„	„	„	„	„	21/3/27	1.025	„ „ „ „ 44
91	„ „ ..	„	„	„	„	„	„	11/3/27	1.025	„ „ „ „ 45
92	„ „ ..	„	„	„	„	„	„	10/2/27	1.024	„ „ „ „ 46

CIDER-MAKING TRIALS WITH TASMANIAN APPLES.

By O. Grove and B. T. P. Barker.

As a result of communications received from representatives of the Australian Government relating to the possibility of use of Australian apples for cider-making, the Institute undertook to carry out some preliminary trials with typical Australian fruit during the course of the fruit season of 1927. The fruit was sent over in boxes to this country from Tasmania, where it was grown, the form of package used being the same as that adopted for the consignment of Australian apples for eating purposes. The Australian Government was responsible for the collection and selection of the material sent.

On arrival at Long Ashton, at Midsummer, most of the fruit was found to be fit for milling and pressing without delay. It was dealt with in the usual way, an attempt being made to filter the respective samples at a specific gravity between 1.020 and 1.030. Some of the samples, however, fermented at an extremely rapid rate and fell below 1.020 before filtration could be effected. From time to time subsequently the ciders have been examined, and the following report embodies the chief features of the results obtained.

The yield of juice was fair to good, except for Fanny, the fruit of which was overripe. The rate of fermentation was rapid to very rapid except in the case of Five Crown Pippin. The ciders were notably soft and lacking in body, with medium to low acidity.

Crows Egg, Five Crown Pippin, Fanny and Crofton are sub-acid varieties and improved by blending with more acid and bittersweet juices. The two first named are promising ; the two latter inferior. The remaining six kinds are more suitable in respect of acidity, but require blending with fuller bodied juices containing more tannin. French Crab is promising ; the remainder inferior, except possibly Nonpareil, which could not be fairly judged owing to a taint in flavour, due to the fruit being in bad condition on arrival.

In addition, a number of blends with ciders prepared from typical English vintage apples have been made. These blends, all of which contain approximately 50 per cent. of the Tasmanian material, tend to show that a satisfactory commercial article could be made from

Tasmanian apples when used in conjunction with true vintage kinds. It is unlikely, however, that a successful commercial cider, according to English standards, could be made from the majority of the Tasmanian varieties tested when used by themselves, either when mixed with one another or singly.

ADAMS PEARMAIN.

Fruit received July 11th, milled and pressed July 18th : condition good.

Analysis of fresh juice : specific gravity 1.056, total solids 13.7%, total sugars 12.6%, malic acid 0.43%, tannin 0.08%, rate of fermentation 14.

Filtration on July 25th at specific gravity 1.011.

A sparkling rather dry cider with a thin, not very pleasant flavour.

CROFTON.

Fruit received June 30th, milled and pressed July 5th : condition very good.

Analysis of fresh juice : specific gravity 1.055, total solids 13.5%, total sugars 12.0%, malic acid 0.30%, tannin 0.07%, rate of fermentation 7.5.

Filtration on July 15th at specific gravity 1.023.

A still cider with a pleasant, soft and light flavour, rather thin and without character.

CROWS EGG.

Fruit received June 23rd, milled and pressed June 30th : condition very good.

Analysis of fresh juice : specific gravity 1.043, total solids 10.7%, total sugars 9.6%, malic acid 0.23%, tannin 0.08%, rate of fermentation 8.1.

Filtration on July 9th at specific gravity 1.021.

A sparkling, pleasant cider of the pure sweet type, soft, rather thin and lacking in body.

FANNY.

Fruit received June 30th, milled and pressed July 1st : condition good externally, but the flesh was rather soft and difficult to press, the fine, soft mush going through the press-cloths. The apples were decidedly past the best stage for cider-making, consequently the yield of juice was low.

Analysis of fresh juice : specific gravity 1.052, total solids 12.81%, total sugars 11.4%, malic acid 0.33%, tannin 0.11%, rate of fermentation 8.

Filtration on July 9th at specific gravity 1.024.

A slightly sparkling, medium sweet, soft, medium brisk cider, with some flavour, but not very attractive.

FIVE CROWN PIPPIN.

Fruit received June 30th, milled and pressed July 5th : condition very good.

Analysis of fresh juice : specific gravity 1.047, total solids 11.6%, total sugars 10.4%, malic acid 0.38%, tannin 0.11%, rate of fermentation 4.

Filtration on July 25th at specific gravity 1.028.

A sparkling, brisk and soft cider with a characteristic flavour. Quite good cider.

FRENCH CRAB.

Fruit received June 30th, milled and pressed July 18th : condition very good.

Analysis of fresh juice : specific gravity 1.064, total solids 15.6%, total sugars 13.8%, malic acid 0.65%, tannin 0.10%, rate of fermentation 14.

Filtration on July 25th at specific gravity 1.024.

A sparkling, pleasant, medium brisk cider with definite vintage character.

NONPAREIL.

Fruit received June 30th, milled and pressed July 1st : condition not good, many being badly bruised and mould growths found in many cases.

Analysis of fresh juice : specific gravity 1.063, total solids 15.5%, total sugars 13.6%, malic acid 0.57%, tannin 0.07%, rate of fermentation 13.3.

Filtration on July 9th at specific gravity 1.020.

A sparkling cider with a fairly good flavour, which was, however, spoiled by a musty flavour due to the state of the apples. Shows possibility of producing a fair cider.

SCARLET PEARMAIN.

Fruit received July 11th, milled and pressed July 18th : condition good.

Analysis of fresh juice : specific gravity 1.052, total solids 12.8%, total sugars 11.4%, malic acid 0.42%, tannin 0.08%, rate of fermentation 10.

Filtration on July 25th at specific gravity 1.015.

A sparkling, medium dry, medium brisk, soft cider, but not very pleasant in character.

STONE PIPPIN.

Fruit received June 30th, milled and pressed July 18th : condition good.

Analysis of fresh juice : specific gravity 1.062, total solids 15.2%, total sugars 13.4%, malic acid 0.56%, tannin 0.13%, rate of fermentation 13.5.

Filtration on July 25th at specific gravity 1.007.

A sparkling, completely dry cider with a brisk, soft, flavour. Resembling cider made from English eating apples.

STURMER PARAMOUNT.

Fruit received on July 11th, milled and pressed July 18th : condition good.

Analysis of fresh juice : specific gravity 1.057, total solids 13.9%, total sugars 12.4%, malic acid 0.56%, tannin 0.09%, rate of fermentation 11.7.

Filtration on July 25th at specific gravity 1.021.

A brisk, soft cider with pronounced flavour, resembling in character cider made from English eating apples.

TRIAL CIDER AND PERRY ORCHARDS.

By

B. T. P. Barker, O. Grove and P. T. H. Pickford.

When the Institute started its career at the end of 1903 its first task in fruit culture was the establishment at Long Ashton of a typical cider and perry orchard, planted for trial purposes with a comprehensive selection of varieties of cider apples and perry pears which the experts of that day regarded as of the highest repute. Recognising that a trial of that kind at a single centre would be inadequate to decide the best kinds of fruit to be grown for cider and perry making in this country, the Committee proceeded concurrently to plant a nursery at the Institute for the propagation of both the varieties included in the afore-mentioned orchard and other sorts deserving of trial. From this nursery trees were to be distributed in due course to suitable centres in the cider-producing districts, so that there should be a series of trial orchards under varied conditions supplementing the main trial at Long Ashton.

The establishment of these external trials, which began in 1908, was possible at the time only by the co-operation of the various County Agricultural Education authorities concerned. Neither the resources nor the staff of the Institute were adequate to permit of a scheme of this scale being run without such local assistance. In recognising the indebtedness of the Institute to those authorities for their help, special acknowledgment must be given to the horticultural staffs of those departments, on whose shoulders the main burden of the scheme has fallen.

The nature of the co-operation required determined the character of the details of the scheme. The trees were presented to the respective County Councils on the understanding that suitable trial orchards would be established with them. The choice of sites and the number of trees allocated to each were left in the hands of those bodies. The selection of varieties in each case was decided in consultation with the Institute and determined as far as possible in relation to the special needs of the districts concerned. The planting and after-care of the orchards was undertaken by the County staffs in arrangement with the occupiers of the land. Comparatively little land belonging to the Councils being available, most of the orchards had to be planted on privately-owned land,

and the trees thus became the property of the respective landowners who had so public-spiritedly provided the trial grounds. The Institute reserved the right of inspection of the orchards at any time for the purpose of making the necessary observations on the trees and obtained promises of supplies of the crops as required later for chemical and cider-making tests at the prevailing market prices for the season.

A scheme of this kind presents several obvious weaknesses and some not so apparent. Possibly the greatest difficulty experienced has been that of a change of ownership or tenancy, accompanied in some instances by indifference or a desire to put the land to other use by the newcomer. However, at the time the scheme appeared the most satisfactory possible under the circumstances and it was recognised that a proportion of failures must be expected.

Past Annual Reports of the Station have contained records of the establishment of individual orchards, details of soil conditions, and occasional accounts of their progress. No attempt has been made so far to consider results in detail, since the oldest of the orchards are but twenty years from the date of planting and the trees are therefore only now approaching the time when their value as orchard trees and their cropping and vintage qualities can be fairly assessed. From now onwards results of real significance should be forthcoming and accordingly arrangements have been made for detailed surveys of the older orchards. During the summer and autumn of 1927 a preliminary survey by one or more of the authors was made of as many as could be visited in the time available, and the outstanding features of each are recorded in the present report. It is intended in succeeding reports to deal more specifically with tree size, disease susceptibility, and cropping tendencies of individual varieties so far as they can be estimated on trees still comparatively young in relation to the respective soil and other local conditions.

All the trial orchards planted before the war were visited during the course of 1927. Most of them were established during 1908-1910, and they have now reached an age when they should be coming into profitable bearing. This series of visits has emphasized the necessity of a period of twenty years or more after planting before a sound judgment can be pronounced as to the value of a variety in a certain district. There have been a number of examples of trees of certain varieties doing well in an orchard up to the age of about 15 years and then in the course of a few more years going rapidly back, generally because of canker or die-back diseases. A striking example of this is the variety Cherry Norman, which in

several orchards grew very satisfactorily until the trees were 12-15 years old and then in the next few years became completely valueless because of canker.

With the exception of canker, which is very serious in the case of some of the varieties, the trees are as a general rule fairly free from the more serious diseases and pests.

The perry pears have in most cases done well, but in a few orchards some of the varieties, especially Barland, have started to canker.

Generally speaking, the orchards in Gloucestershire and Monmouthshire are the best. On the whole these are very satisfactory and give evidence of closer attention than the orchards in the other counties. Their sites seem to have been better selected and the grass is generally in good condition, which is not the case with some of the other orchards, where the grass has become long and coarse.

Devonshire Orchards.

King's Nympton: planted in 1908.

Varieties.—Cherry Pearmain, Skyrme's Kernel, Broadleaf Norman, Sweet Coppin, Chisel Jersey and Knotted Kernel.

The Cherry Pearmain trees have suffered from canker and are not growing well. Broadleaf Norman and Sweet Coppin have formed good trees and are quite satisfactory. Chisel Jersey is only fairly good, but Knotted Kernel has formed excellent trees.

Okehampton: planted in 1908.

Varieties.—Cowarne Red, Redstreak, Broadleaf Norman, Cummy Norman, Cherry Norman and Knotted Kernel.

The only variety which is growing satisfactorily is Knotted Kernel. The soil in this orchard is not suitable (see 1919 report).

Branscombe: planted in 1910.

Varieties.—Eggleton Styre, Strawberry Norman, Foxwhelp and Kingston Black.

Eggleton Styre is doing well and Strawberry Norman very well. Foxwhelp has only made fair growth and the Kingston Black trees are very moderately developed.

Dorsetshire Orchards.

Two orchards were planted in this county, one at Loders and one at Sherborne.

Loders : planted in 1908.

Varieties.—Foxwhelp, Neverblight, Rouge de Treves, Broadleaf Norman, Court Royal, Cremière, Eggleton Styre, Medaille d'Or, Virgin Mary and Yarlington Mill.

The situation of this orchard is very poor. It is very low-lying and the soil at one end of the orchard near a stream is extremely wet. As a result the trees near this brook are dying. It is understood that until quite recently this orchard was drained successfully, but the draining has been neglected during the last year or two. Attention has been drawn to this matter and it is hoped that when the drains are opened the conditions will be improved. Cremière, Broadleaf Norman, Yarlington Mill and Eggleton Styre have done fairly well and are cropping well. These were all planted in the highest part of the orchard. Neverblight has done fairly well, but the trees are rather small. Medaille d'Or, Rouge de Treves and Foxwhelp, planted where the soil is waterlogged, are very poor specimens and many of them appear to be beyond recovery.

Sherborne : planted in 1909.

This orchard was a failure from the beginning. The site was most unfavourable and the trees made no progress from the start, all of them now being dead.

Gloucestershire Orchards.

The trial orchards in this county generally have done very well and most of the varieties have been successful. All the orchards were visited and reported upon in 1919 (see the 1919 Annual Report).

May's Hill, Frampton Cotterell : planted in 1909.

Varieties.—Apples—Cherry Pearmain, Kingston Black, Sweet Alford, Knotted Kernel, Strawberry Norman, Red Foxwhelp, Eggleton Styre, Stubbard, Cherry Norman and Medaille d'Or.

Pears—Taynton Squash, Oldfield and Barland.

The Cherry Pearmain trees, which in 1919 were in poor condition, have recuperated to a certain extent and are now doing moderately well. Kingston Black is not doing well in this orchard ; the trees are stunted and have started to canker. Sweet Alford is very satisfactory. Knotted Kernel has not grown so well in this orchard as is usual with the variety, the trees being small but healthy. Strawberry Norman has developed into very good trees, but a little canker has started to develop in places. Red Foxwhelp is only moderate. Eggleton Styre has done very well indeed and the same

is the case with Stubbard. Cherry Norman is a complete failure, due to canker. The Medaille d'Or trees, which were moved to a better sheltered orchard, are doing moderately well, but on the whole the variety has not been successful. As a general rule the trees in the higher parts of the orchard are better than those in the lower part, which is rather wet.

The three varieties of pears, Taynton Squash, Oldfield and Barland, all grew satisfactorily but, as the owner did not want perry pears, he has had the trees regrafted to dessert pears.

Road Farm, Hardwick Court: planted in 1908.

Varieties.—Apples—Kingston Black, Skyrme's Kernel, Ecarlatine, Eggleton Styre, Sweet Alford, Cummy Norman, Medaille d'Or, Royal Wilding and Strawberry Norman.

Pears—Oldfield and Barland.

With the exception of Medaille d'Or all the above named varieties of apples have made very satisfactory progress, all the trees have developed very well, and no cases of disease have appeared. The Medaille d'Or trees, which were most unsatisfactory, have either been regrafted to other varieties or replaced. Two trees of White Close Pippin planted instead of Medaille d'Or are doing very well.

With regard to the pears, the Oldfields have formed very good trees but have started to die back. The Barland pear trees have done badly and have been regrafted to Longdon pear.

Holm's Farm, Lydney Park: planted in 1908.

Varieties.—Apples—Cowarne Red, Dymock Red, Foxwhelp, Cremière, Doux Amer, Sweet Coppin, Chisel Jersey, Knotted Kernel and Yarlington Mill.

Pears—Moorcroft and Taynton Squash.

Cowarne Red has started to canker, some of the trees very badly, and most of the trees will probably die from this disease in a few years time. Of the other varieties Dymock Red and Knotted Kernel have done very well indeed and Sweet Coppin, Cremière and Doux Amer have also developed very satisfactorily. Foxwhelp is not satisfactory and Chisel Jersey and Yarlington Mill are only moderate.

Both the pears are very satisfactory.

Floodgate Farm, Berkeley Castle : planted in 1908.

Varieties.—Apples—Cap of Liberty, Kingston Black, Improved Pound, Eggleton Styre, Killerton Sweet, Sweet Alford, Cherry Norman, Rouge Bruyère and Royal Jersey.

Pears—Barland and Moorcroft.

Cap of Liberty is very satisfactory. Kingston Black has done very well, but some of the trees have now started to develop a little "die-back." With the exception of Cherry Norman all the other varieties are very satisfactory. Sweet Alford is especially successful. Cherry Norman has started to canker rapidly and will be regrafted with Kingston Black.

With regard to the pears, Moorcroft is satisfactory, but Barland is in very poor condition.

Tibberton : planted in 1909.

Varieties.—Cap of Liberty, Cowarne Red, Kingston Black, Eggleton Styre, Sweet Alford, Dabinett, Knotted Kernel, Medaille d'Or and Strawberry Norman.

Cap of Liberty, Kingston Black, Eggleton Styre, Sweet Alford, Knotted Kernel and Strawberry Norman have all done very well; especially good are Sweet Alford and Kingston Black. Dabinett and Medaille d'Or have already been headgrafted with other varieties (see 1919 Annual Report), as they did not do at all well. Cowarne Red is hopelessly spoiled by canker.

Herefordshire Orchards.

Burghill Asylum : planted in 1908-9.

Varieties.—Dabinett, Improved Pound, Sweet Alford, Eggleton Styre, Court Royal, Broadleaved Jersey, Strawberry Norman, Fair Maid of Devon, Sweet Coppin, Knotted Kernel, Dymock Red, Yarlington Mill, Cherry Norman, Killerton Sweet, Hereford Redstreak, Somerset Redstreak, Butleigh 14, No. 32, Kingston Black Improved, Kingston Black, Foxwhelp, Skyrme's Kernel, Cowarne Red, and Medaille d'Or.

Dabinett, Improved Pound, Sweet Alford, Eggleton Styre, Court Royal, Broadleaved Jersey, Strawberry Norman, Fair Maid of Devon, Sweet Coppin, Knotted Kernel, Dymock Red, Yarlington Mill, Cherry Norman and Killerton Sweet have done very well, this being especially so in the cases of Sweet Alford and Fair Maid of Devon. Several of the Cap of Liberty trees are rather small. The Hereford Redstreaks are fair trees but small. The Somerset Redstreaks are rather larger. Butleigh 14 has not made good growth.

No. 32 has only made small trees, but they are quite healthy. Kingston Black Improved are rather small but fairly good. Kingston Black has not done well: some are just fair, but at one end of the orchard they are very small indeed. Foxwhelp and Skyrme's Kernel have not made much growth; the trees are rather small, but they appear to be quite clean and healthy. Cowarne Red is evidently recovering from canker and has made healthy growth. The Medaille d'Or trees have been regrafted with other varieties (see 1919 Annual Report).

Monmouthshire Orchards.

Llansaintfraid: planted in 1908.

Varieties. Kingston Black, Redstreak, Eggleton Styre and Medaille d'Or. (Knotted Kernel was planted in 1909).

Kingston Black has done very well and is carrying fair crops. Redstreak and Eggleton Styre have also done well and have made big fine trees. Medaille d'Or is not satisfactory: the trees are very small and have broken down badly. Knotted Kernel has formed good trees but they have not yet carried a crop. In a good season this orchard will no doubt produce a valuable crop.

Treowen: planted in 1908.

Varieties.—Kingston Black, Foxwhelp, Cherry Norman and Knotted Kernel. (Further trees of Knotted Kernel and Cap of Liberty were planted in 1909).

All the varieties have made good growth, though Cap of Liberty has not done so well as the others. Kingston Black and Cherry Norman have made the best trees, whilst Foxwhelp and Knotted Kernel are quite satisfactory. Although this orchard has been very backward in coming into bearing, the owner considers that given a good season there would now be a successful crop. There was a decided improvement in the crop during 1927, Cherry Norman and Foxwhelp carrying fairly good crops and Kingston Black giving a fair amount of fruit.

Itton Court: planted in 1908.

Varieties.—Apples—Cap of Liberty, Eggleton Styre, Knotted Kernel and Strawberry Norman. (Further trees of Eggleton Styre and Kingston Black were planted in 1909).

Pears—Moorcroft, Barland, Taynton Squash and Oldfield.

The fact that some varieties are cankering badly in this orchard, is evidently due to the soil being very shallow and rocky where they are planted. Eggleton Styre and Knotted Kernel, planted where the soil is deeper, have done well and have made big fine trees. Cap of Liberty has done excellently, but the trees are now beginning to canker slightly. The Strawberry Norman trees are suffering very badly from canker, although they have made fine growth. Kingston Black, which was planted in the worst part of this orchard, has done badly and the trees are nearly all suffering from canker. Cap of Liberty, Strawberry Norman and Eggleton Styre carried a sparse crop of fruit in 1927.

The perry orchard has been a failure. The texture of the soil is undoubtedly the cause. Taynton Squash is the best of a bad lot. Barland is the worst, and the trees are in a bad condition. An attempt has recently been made to improve the trees by cultivating the soil around them, and they were all pruned and sprayed during last winter. It is doubtful, however, whether any cultivation or manurial treatment will overcome the physical defects of the soil.

Tyllwydd, Llangwn, Usk: planted in 1908.

Varieties.—Cap of Liberty, Kingston Black, Royal Jersey and White Jersey. (Dymock Red was planted in 1909).

Kingston Black, Cap of Liberty and White Jersey have done well and have formed good trees. Royal Jersey has done satisfactorily, but the trees are rather small. Dymock Red has made fair growth but the trees are not so healthy as the others. Royal Jersey and White Jersey carried good crops.

Rhiwderin: planted in 1908-9.

Varieties.—Rouge de Treves, Cremière, Doux Amer, Ecarlatine, Bramtôt, Medaille d'Or, Tardive Forestier, Frequin Rouge and Rouge Bruyère.

Doux Amer has been the most satisfactory. Cremiére and Ecarlatine have made very fine trees, but Cremiére is cankering badly, and Ecarlatine slightly. Medaille d'Or has done fairly well and the breaking down has been overcome by pruning breaking branches hard back. Rouge Bruyère has not done so well and one or two trees are suffering from canker. They have never carried a good crop of fruit. Rouge de Treves has done fairly well, but has not made such fine growth as some of the other varieties. Bramtôt has done well, while Tardive Forestier and Frequin Rouge have made moderate trees. Doux Amer, Rouge de Treves and Medaille d'Or carried a good crop of fruit.

Bassaleg : planted in 1908-9.

Varieties.—Fair Maid of Devon, Sweet Alford, Chisel Jersey and Dabinett.

This orchard is one of the best in the county. All the trees have done well, especially Fair Maid of Devon and Sweet Alford, which are excellent. Dabinett has formed good trees, and they were bearing a good crop this year. The Chisel Jersey are rather small but quite satisfactory and bearing well. This orchard has carried fine crops of fruit. Sweet Alford bears exceedingly well.

Llandewi Court : planted in 1909.

Varieties.—Barland, Butt, Claret, Dandoc, Helen's Green, Holmer, Moorcroft, Oldfield, Pine and Taynton Squash.

All the varieties in this perry orchard have done well, with the exception of Barland and Pine. Moorcroft, Taynton Squash and Oldfield have done best, while Claret, Butt and Holmer are satisfactory. Dandoc has not done quite so well, but the trees are not in a favourable position. Barland and Pine have not done well; although they have made fine trees they are suffering badly from canker.

The Hendre : planted in 1911.

Varieties.—Redstreak, Kingston Black, Cap of Liberty, Dymock Red, Knotted Kernel, Silver Cup and Royal Wilding.

Most of the varieties have done fairly well, taking into consideration the fact that they were planted in new unweathered soil. Cap of Liberty has done the best; the trees are very healthy and well developed. Kingston Black has made fairly good growth and the same applies in the case of Royal Wilding. Dymock Red, Silver Cup and Knotted Kernel have not done so well as the other varieties. There was a good crop this year on Kingston Black and Cap of Liberty, while Knotted Kernel had a fair crop.

Old Court, Abergavenny : planted in 1910-11.

Varieties.—Barland, Huffcap, Oldfield and Taynton Squash.

All the trees in this perry orchard have done remarkably well. Taynton Squash and Oldfield were bearing good crops in 1927. Barland has formed fine trees but they are not yet bearing much fruit. The Huffcap trees are making fairly good progress.

The Hendre Home Farm : planted in 1908.

Varieties.—Blakeney Red, Barnett, Port, Butt, Claret, Moorcroft, Taynton Squash, Oldfield and Barland.

This is a remarkably good perry orchard. The trees on the whole have done very well, though some were bearing shyly this year. Blakeney Red is the best, and Barnett, Port, Butt, Claret, Moorcroft and Taynton Squash have all made fine trees. Oldfield was bearing a good crop, but the trees have not developed so well as the others and are not so healthy. Only one Barland remains. Blakeney Red, Barnett and Taynton Squash were carrying good crops this year.

Somerset Orchards.

The orchards in this county are upon the whole not so good as the orchards in Gloucester and Monmouth (see also 1919 Annual Report).

Barton St. David : planted in 1908.

Varieties.—Apples—Cowarne Red, Hereford Redstreak, Skyrme's Kernel, Broadleaf Norman, Cummy Norman, Eggleton Styre, Combes Cadbury, Sweet Coppin and Strawberry Norman.

Pears—Barland, Moorcroft, Oldfield and Taynton Squash.

Cowarne Red has done badly in this orchard ; there are only six trees left of the ten planted, the rest having cankered and died. Of the six left, two trees are moderately good, the others being undersized and attacked by canker. The row of this variety is in a part of the orchard that is rather wet. Hereford Redstreak has not done well, and most of the trees have been regrafted with culinary varieties. Of the Skyrme's Kernel trees only one is doing well, the others being small and suffering from canker ; they are in the wettest part of the orchard. Broadleaf Norman, Cummy Norman, Eggleton Styre, Combes Cadbury and Strawberry Norman all show satisfactory development. All the Sweet Coppin trees, which in 1919 were very well developed, have unhappily been regrafted with culinary varieties.

The owner has had nearly all the perry pears regrafted with dessert varieties. There are only two trees of Oldfield left, and they are rather stunted in growth and dying back.

Clutton : planted in 1908.

Varieties.—Apples—Foxwhelp, Kingston Black, Never Blight, Cremière, Eggleton Styre, Sweet Alford, Knotted Kernel, Medaille d'Or.

Pears—Barland, Moorcroft and Oldfield.

The Foxwhelps have not done well ; the trees are stunted in

growth but are otherwise healthy. Kingston Black has done very badly ; most of the trees are dead and the remainder are small and badly cankered. Never Blight and Cremière are not satisfactory ; the latter have started to die back. Eggleton Styre and Sweet Alford are only very moderate. The Knotted Kernel trees are fairly good, but not nearly so well developed as is usual with this strong growing variety. Medaille d'Or has mostly been regrafted as this variety was doing badly and breaking down.

Of the pears, Barland is doing badly ; the trees are cankered and full of Scab. Some of the Taynton Squash and Moorcroft trees are fairly satisfactory in the higher parts of the orchard. The Oldfields were planted in the lower and rather wet part of the orchard, and they are not very well developed.

East Compton, Shepton Mallet : planted in 1908.

Varieties.—Apples—Foxwhelp, Hereford Redstreak, Skyrme's Kernel, Eggleton Styre, Sweet Alford, Cherry Norman, Knotted Kernel and Strawberry Norman.

Pears—Barland, Moorcroft, Oldfield and Taynton Squash.

The condition of the trees in this orchard is to a great extent determined by the shallowness of the soil. In most places the depth of the soil above the rock is not sufficient to permit the trees to develop normally, and consequently the trees are undersized and badly developed in many cases. Here and there, where the depth of the soil is adequate, normally developed trees are found but, on on the whole, this orchard is far from satisfactory. Foxwhelp, Hereford Redstreak, Skyrme's Kernel and Knotted Kernel are the varieties which have done best, and which show some satisfactory trees. Sweet Alford and Eggleton Styre show a few trees with fair development. Cherry Norman and Strawberry Norman are suffering from canker.

The pears are nearly all unsatisfactory, and many of the trees are attacked by canker.

It would appear that the site of this orchard is quite unsuited for trials of this kind.

Christon Court, Axbridge : planted in 1908.

Varieties.—Apples—Cherry Pearmain, Cowarne Red, Dymock Red, Foxwhelp, Redstreak, Broadleaf Norman, Killerton Sweet,

Stubbard, Cherry Norman, Cummy Norman, Harry Masters, Major, Medaille d'Or, Royal Wilding and Yarlington Mill.

Pears—Barland, Barnett, Blakeney Red, Butt, Oldfield, Pine and Taynton Squash.

The Cherry Pearmain trees are not very well developed : they are mostly too small, but healthy. Cowarne Red has done very badly ; the trees are dying back and badly cankered. Dymock Red shows very satisfactory growth. Foxwhelp is doing badly ; the trees are small and appear to be dying. Redstreak is only moderate ; the trees are under-developed. Broadleaf Norman is fair ; the trees have, however, started to canker. Killerton Sweet and Stubbard are both doing very satisfactorily. Cherry Norman is a failure ; the trees are dying from canker. The Cummy Norman trees are also suffering from canker, especially in the lower part of the orchard. Harry Masters has formed fairly good trees ; they are best in the higher part of the orchard. Major is satisfactory. Medaille d'Or is not very good, and the trees are breaking down. Royal Wilding and Yarlington Mill are not as well developed as could be desired. Some trees of Silver Cup planted later than 1909 are doing very well.

Of the pears Barnett, Taynton Squash and Blakeney Red are very satisfactory. The other three are not quite so good. The Oldfields are suffering to a certain extent from Scab and " Die-back."

Worcestershire Orchards.

Madresfield Court : planted in 1908.

Varieties.—Apples—Cap of Liberty, Foxwhelp, Cherry Pearmain, Cowarne Red, Dymock Red, Fair Maid of Devon, Never Blight, Skyrme's Kernel, Broadleaf Norman, Court Royal, Improved Pound, Sweet Alford, Sweet Coppin, Cherry Norman, Dabinett, Knotted Kernel, Medaille d'Or, Rouge Bruyère and Strawberry Norman.

Pears—Barland, Butt, Oldfield, Moorcroft, Pine and Taynton Squash.

Medaille d'Or are small trees but healthy ; they appear to have recovered from breaking down so badly in early life. Never Blight, Dabinett and Cherry Pearmain are small but quite sturdy and bearing well. All the other varieties are very satisfactory.

Regarding the pears Butt has done the best and formed very fine trees. Taynton Squash, Moorcroft and Pine are all good trees. Barland and Oldfield have made fine trees but they are suffering slightly from canker.

Newnham Court, Tenbury : planted in 1908-9.

Varieties.—Broadleaf Jersey, Broadleaf Norman, Knotted Kernel, Medaille d'Or, Strawberry Norman and Cherry Norman.

Strawberry Norman, Cherry Norman, Knotted Kernel and Broadleaf Jersey have all done well. Broadleaf Jersey has done remarkably well. Broadleaf Norman, planted on the top of the hill where the soil is rather shallow, has not done so well. Many trees of this variety have been replaced. All the Medaille d'Or trees have been regrafted, as they were not a success. There was a fair crop of fruit on Cherry Norman and Broadleaf Norman. Strawberry Norman was bearing very irregularly.

Powick Asylum : planted in 1908.

Varieties.—Foxwhelp, Hereford Redstreak, Broadleaf Norman, Eggleton Styre, Knotted Kernel and Strawberry Norman.

All the varieties have done fairly well, but they are undersized. The orchard has been stocked with pigs and, as the trees were not protected, the trunks have been damaged in some cases. Broadleaf Norman, Knotted Kernel and Strawberry Norman have done best. Eggleton Styre and Foxwhelp have done fairly well, but the Foxwhelp trees are small. Knotted Kernel has not yet carried a good crop. Broadleaf Norman and Hereford Redstreak have been badly damaged by stock, but were bearing good crops this year. There was a fair amount of fruit on Strawberry Norman.

Hyde Farm, Upton : planted in 1908.

Varieties.—Kingston Black, Court Royal, Ecarlatine, Harry Masters, White Jersey and Fair Maid of Devon.

These trees have evidently made headway since they were last reported on. Court Royal, Fair Maid of Devon, Ecarlatine and Harry Masters have all made good trees. Fair Maid of Devon and Harry Masters were carrying a heavy crop of fruit. Court Royal was bearing fairly well. Ecarlatine has made fine growth, but the trees are cropping irregularly. Kingston Black has made very poor growth. Although the trees are very small they appear to be quite healthy, and they are bearing a good crop. The same applies to White Jersey. These trees appear to have suffered from lack of attention when they were younger, but they are evidently overcoming this.

Wollas Hill, Pershore: planted in 1908.

Varieties.—Apples—Foxwhelp, Skyrme's Kernel and Sweet Alford.

Pears—Barland and Oldfield.

Sweet Alford has made excellent trees with fine heads. They were bearing a good crop this year. Skyrme's Kernel also made very fine trees and were carrying a fair crop of fruit. Foxwhelp has not done well. The trees are small and not healthy. Barland has done remarkably well. The trees are big, well developed and healthy. The Oldfields have also done well and formed good trees. There was only a very light crop of fruit on the pears this year.

The Stocks, Suckley: planted in 1909.

Varieties.—Cherry Pearmain, Kingston Black, Knotted Kernel and Strawberry Norman.

Kingston Black, Knotted Kernel and Strawberry Norman have made excellent trees. The Kingston Black trees are by far the best of this variety in the county orchards. Cherry Pearmain has not done well. The trees are very small and do not appear healthy. There was only a very light crop of fruit in this orchard in 1927.

Beauchamp Court: planted in 1912-13.

Varieties.—Apples—Sweet Alford, Eggleton Styre and Cap of Liberty.

Pears—Taynton Squash, Butt, Moorcroft, Barnett, Blakeney Red, Dandoc and Barland.

Sweet Alford has done remarkably well; they are very big, fine trees. Eggleton Styre is quite satisfactory. Cap of Liberty, planted in a wet part of the orchard, has not done well; the trees have made very little growth and are not healthy.

Taynton Squash, Butt, Moorcroft, Barnett and Blakeney Red have all formed good trees, especially Barnett, which has done very well. Two Dandocs have not done so well as these other varieties, though this may be due to soil conditions not being so favourable. The trees were planted at the bottom of the orchard where the soil is rather wet, but another Dandoc tree planted higher up has developed quite satisfactorily. Oldfield and Pine have not done well. Barland has made poor growth and is suffering badly from canker.

There was a very poor crop of fruit in this orchard in 1927. The frost caused serious damage to the blossom in this district.

Cider-Making Trials.

With regard to ciders made from the above trial orchards, it has so far been difficult to get fruit of a single variety in sufficient quantity for a cider making trial on a large scale, for which about half a ton is required, but from some of the orchards trials have been carried out with a mixture of the varieties grown. This is the case with all the orchards in Gloucestershire, and the results have been very satisfactory ; in each instance a cider of good quality has been made from the blend.

In some cases the owners of the orchards have not desired to part with the fruit as it fetched a good price in the market as pot-fruit, and in other cases they have wanted the fruit for their own cider making. As the trees are now coming into full bearing, it is hoped to get sufficient fruit for large scale trials in the near future.

Tabulation of Results.

For convenience of reference and comparison the following table has been prepared. It indicates the manner in which individual varieties have grown in each trial orchard. The varieties which have made thoroughly satisfactory growth and produced strong healthy trees are placed in Class 1, indicated by the figure 1 in the table. Class 2 varieties, indicated by the figure 2 in the table, are those which have given satisfactory trees, but not so strong generally as those indicated in Class 1. The Class 3 varieties, indicated in the table by figure 3, have given fairly satisfactory results. Class 4 varieties, indicated by the figure 4 in the table, have made poor growth. Class 5 varieties, indicated by the figure 5 in the table, are those which have been complete failures.

Variety of Apple.	ORCHARDS.																															Average Class Figure
	Devon			Dorset	Gloucester					Hereford	Monmouth											Somerset				Worcester							
	King's Nympton	Okehampton	Branscombe	Loders	Frampton Cotterell	Hardwick	Lydney Park	Berkeley Castle	Tibberton	Burghill	Llansaintfraed	Treowen	Itton Court	Tyllwydd, Llangwn	Rhiwderin	Bassaleg	Llanddewi Court	The Hendre	Old Court, Abergavenny	The Hendre Home F'rm	Barton St. Davids	Clutton	East Compton	Axbridge	Madresfield	Newnham Court	Powick Asylum	Hyde Farm, Upton	Wollas Hill	The Stocks, Suckley	Beauchamp Court	
Bramtot										2					3																	3.0
Broadleaf Jersey ..																										1						1.5
Broadleaf Norman ..	2	5		2																	2			3	1	2	3					2.5
Cap of Liberty ..								2	2	3		3	3	1				2							2						5	2.5
Cherry Norman ..		5			5			3		2		1	5											5	2		3					3.6
Cherry Pearmain ..	3				3																			3						4		3.2
Chisel Jersey	3						3									3																3.0
Court Royal				5						2															2			2				2.7
Cowarne Red		5					4		5	3											5			5								4.5
Crémière				3			2								3							4										3.0
Cummy Norman ..		5				2								2							2			4								3.2
Combes Cadbury ..																					2											2.0
Dabinett									5	2						1									2							2.5
Doux Amer							2								1																	1.5
Dymock Red							1			2				2				3						2	2								2.0
Ecarlatine						2									3													2				2.3
Eggleton Styre.. ..			2	2	2	2		2	2	2	1		2									3	3								2	2.1
Fair Maid of Devon ..										2						1									2			1				1.5
Foxwhelp			3	5			4			3		1										3	3	5	2		3		4			3.3

Class 1.—Excellent. Class 2.—Good. Class 3.—Moderate. Class 4.—Poor. Class 5.—Bad.

Variety of Apple.	ORCHARDS.																													Average Class Figure
	Devon			Dorset	Gloucester					Hereford	Monmouth										Somerset				Worcester						
	King's Nympton	Okehampton	Branscombe	Loders	Frampton Cotterell	Hardwick	Lydney Park	Berkley Castle	Tibberton	Burghill	Llansaintfraed	Treowen	Itton Court	Tyllwydd, Llangwn	Rhiwderin	Bassaleg	Llanddewi Court	The Hendre	Old Court, Abergavenny	The Hendre Home F'rm	Barton St. Davids	Clutton	East Compton	Axbridge	Madresfield	Newnham Court	Powick Asylum	Hyde Farm, Upton	Wollas Hill	The Stocks, Suckley	Beauchamp Court	
Frequin Rouge ..															3																3.0
Harry Masters ..																							3					2			2.5
Hereford Redstreak ..		5								3	1										4		3	3			3				3.1
Improved Pound ..								2		2															2						2.0
Killerton Sweet ..								2		2														2	2						2.0
Kingston Black ..			3			2		2	1	3	2	1	4	2				3				5						3		1	2.4
Kingston Black Improved										3																					3.0
Knotted Kernel ..	1	2			3		1		2	2	2	2	2					3				3	3		2	2	3			1	2.1
Medaille d'Or				5	4	5			5		3				3							5		4	3	5					4.2
Major																								2							2.0
Never Blight				3																		4			3						3.3
Royal Jersey								2						3																	2.5
Royal Wilding ..						2												2						3							2.3
Rouge Bruyère ..								2							3										3						2.6
Rouge de Treves ..															3																3.0
Silver Cup																		3						2							2.5
Skyrme's Kernel ..	3					2				3											4		3		2				2		2.7
Strawberry Norman ..			2		2	2				2			4								2				2	2	3			1	2.2
Stubbard ..					1																			2							1.5

Class 1.—Excellent. Class 2.—Good. Class 3.—Moderate. Class 4.—Poor. Class 5.—Bad.

Variety of Apple.	ORCHARDS.																														Average Class Figure
	Devon			Dorset	Gloucester					Hereford	Monmouth											Somerset				Worcester						
	King's Nympton	Okehampton	Branscombe	Loders	Frampton Cotterell	Hardwick	Lydney Park	Berkley Castle	Tibberton	Burghill	Llansaintfraed	Treowen	Itton Court	Tyllwydd, Llangwn	Rhiwderin	Bassaleg	Llanddewi Court	The Hendre	Old Court, Abergavenny	The Hendre Home F'rm	Barton St. Davids	Clutton	East Compton	Axbridge	Madresfield	Newnham Court	Powick Asylum	Hyde Farm, Upton	Wollas Hill	The Stocks, Suckley	Beauchamp Court	
Sweet Alford					2	2		1	1	2						1						3				2			1		1	1.6
Sweet Coppin ..	2						2			2											2				2						2.0
Tardive Forestier ..															2																2.0
Yarlington Mill ..				2			3			2														3							2.5
Pears—																															
Barland					2	5		5									5		2	5					3				1		4	3.5
Barnett																				2				2							2	2.0
Blakeney Red ..																				2				2							2	2.0
Butt																	2			2					1						2	1.7
Claret																	2			2												2.0
Dandoe																	2														3	2.5
Helenns Green ..																	3															3.0
Holmer																	2															2.0
Huffcap																			3													3.0
Moorcroft							2										2			2		3			2							2	2.1
Oldfield					2	3											2		1	3	4	3		4	3				2		3	2.7
Pine																	4								2						3	3.0
Port																				2												2.0
Taynton Squash ..					2		2										2		1	2	2				2						2	1.8

Class 1.—Excellent. Class 2.—Good. Class 3.—Moderate. Class 4.—Poor. Class 5.—Bad.

PRELIMINARY EXPERIMENTS ON COMMERCIAL CANNING.

By A. Appleyard and F. Hirst.

Badsey Experiments.

Owing to the unsettled industrial conditions prevailing during 1926, the forward prices for plums obtaining in the early summer were so low that most growers in the Evesham district became alarmed at the prospect of serious loss. The Littleton and Badsey Growers, Ltd.—a Society with a membership of approximately 300 growers—applied to the Research Station for help in connection with their endeavour to avert the impending disaster.

It was decided to improvise machinery and plant and to preserve a certain quantity of the available crop by canning, in order to secure data with regard to packing and processing under conditions which would not entail heavy loss to the Society. Moreover, it was felt desirable to explore the economics of fruit canning, (so far as improvised equipment would allow), in view of the part which the canning industry is likely to play in the future marketing of fruit.

A small marine type of boiler and a 3-H.P. oil engine were installed by the Society, whilst a semi-automatic can-seaming machine and sterilising tanks were loaned to the Society by the Research Station.

The plums were washed and graded for size and maturity by hand. They were then packed into No. $2\frac{1}{2}$ American size cans. The syrup was prepared by dissolving sugar at the rate of 4 to 6 lbs. to the gallon of water, in a steam jacketed copper jam pan. As a batch of syrup was prepared, it was poured hot into a steam-jacketed syrup store tank. The latter vessel was furnished with a plug cock, over which muslin was tied to act as a filter. Hot syrup was poured by hand from jugs over the fruit in the cans, which were then closed by the power driven seaming machine. Batches of closed cans were placed on wire trays, which were then lowered into open sterilising tanks.

In the preliminary experiments, 20% of the cans developed leaks during sterilisation. This result was first of all thought to be due to a faulty setting of the rollers on the closing machine. After careful overhauling of this machine the work continued, but many

leaky cans were detected. The leaks developed after a heating period of approximately ten minutes, and it soon became evident that the cans which were being used were too rigid. After more flexible lids had been secured from the can manufacturers, the leakers were reduced to 1%.

Experiments were carried out to ascertain the heating period necessary to prevent fermentation on subsequent incubation of the cans of fruit. The nature and amount of infection on the fruit varied, and the processing or heat treatment of the filled cans had of necessity to be determined by experience rather than by scientific experiments in which the kind and quantity of infection are known. Moreover, the rate of heat transference to the cans is dependent on several factors which, under the conditions prevailing at Badsey, were not capable of control.

The period of heating in boiling water was varied from 25 to 10 minutes. The most satisfactory results were obtained when the No. 2½ cans were immersed in boiling water for 12 minutes, and the gallon cans for 25 minutes. In all, 2,000 cases of No. 2½ cans, and 200 cases of gallon cans of plums and damsons were packed. Entirely satisfactory results were secured with the following varieties: Pershore, Magnum Bonum, Victoria, Late Red, and the Prune Damson. As a result of these experiments, the can manufacturers have made a special study of the requirements—particularly in respect of tin-plate—for fruit cans, and are now in a position to supply cans entirely suitable for the purpose.

The products obtained were regarded as satisfactory. The cost data, taken in conjunction with the fact that the work was carried out under difficult conditions with improvised equipment, were so encouraging that this Society has decided to instal a complete automatic American canning line to afford an alternative outlet for fruit in the centre of so important a fruit growing area as the Vale of Evesham.

Maidstone Experiments.

Apple Canning.

With a view of ascertaining if canning would afford a suitable outlet for certain grades of cooking varieties of apples, machinery and plant were installed by the staff of the Research Station at the British Fruit Packing Company's premises, at Maidstone. This Company has established a central packing Station in the midst of a large apple growing area, and grades and packs apples on the most approved lines.

A vertical boiler with steam and water lines was erected, and modern machinery for peeling, coring, and slicing apples, known as the Coons Unit System, was supplied by Coons Manufacturing Co., Rochester, New York. This latter has a capacity of two to three tons per day, depending upon the size of the apples dealt with, and consists of two semi-automatic feeders and parers, one roller inspection table, and one automatic seedcell-slicing machine. The complete unit was installed adjacent to a Cutler Grader in such a way that apples unfit for packing for the fresh market could be readily transferred to the peeling machines.

Equipment to deal with the sliced apples automatically was purchased from America and installed on a floor below the slicing machine It consists of a brine apple spray washer, a preheater, disc type exhaust box, a 200-can No. 10 square tank single positive discharge cooker, and a 60-can automatic cooler, along with a semi-automatic No. 12 Bliss can closing machine.

Owing to the failure of the apple crop in Kent, in 1926, only two tons of apples were available for the experiment. These consisted of the varieties Bramley and Newton Wonder. After slicing and brining, they were put through the preheater at a temperature of 170° F. The temperature of the exhaust box was maintained at 180° F., and this combined with the cooking period of 20 minutes in the discharge cooker was found to effect sterilisation.

In this preliminary experiment, the pack was unsatisfactory, particularly in respect of colour of the apple slices. Although satisfactory results were not secured, it was made obvious that the two main conditions which require investigation are :—

1. The brining of the fruit.
2. The temperature of preheating before packing.

It was also evident that the greatest care must be exercised to remove damaged tissue at the roller inspection table, and that it is essential that different varieties of apples must not be mixed if uniformly satisfactory results are to be secured. Owing to the small quantity of fruit available, it was possible only to carry out this preliminary experiment. There are many variable factors involved in the process of apple canning, all of which require investigation. These experiments will be continued next season.

Plum Canning.

Equipment for canning plums was erected at Maidstone, by the Staff of the Research Station.

The fruit on a belt conveyor was hand-graded in respect of size into three grades. It was then washed in open tanks, where the stalks were removed. The prepared fruit was filled into standard No. $2\frac{1}{2}$ cans and transported to the can closing machine on a belt conveyor. The fruit was then covered with hot syrup, which was poured over the fruit from jugs, after which the cans of fruit were closed with a power-driven machine. After closing, the cans were heated in open sterilising tanks, in batches of 48. The syrup made by dissolving 6 lbs. of sugar per gallon of water was found to give the best results.

Ten minutes exposure to boiling water was found adequate to effect sterilisation.

Entirely satisfactory results were obtained with the varieties Early Rivers and Victoria, whilst ripe Czars proved entirely unsatisfactory. The small Farleigh damson also proved suitable for canning. Approximately 30,000 No. $2\frac{1}{2}$ cans of plums were produced in these trials.

Taken in conjunction with the results obtained at Badsey, these experiments indicate that excellent products can be produced from some of the most important varieties of English plums.

EXPERIMENTS ON THE PRODUCTION OF ENGLISH FRUIT JUICES AND SYRUPS.

By A. Appleyard and F. Hirst.

In view of the importation into this country of considerable quantities of fruit juices and fruit syrups, combined with a more extended use of artificial flavouring essences, it seemed desirable to ascertain to what extent the former could be obtained from home-grown fruit. The increased cost of alcoholic drinks has led to a more extensive use of the soda-fountain, in which considerable quantities of artificial preparations consisting of synthetic organic esters, mixed with essential oils, are frequently used.

The production of unfermented fruit beverages has become a considerable industry in America, and so-called soft drinks are becoming more popular in England. The establishment of any industry dependent on home-grown supplies of fruit is to some extent hampered by the fluctuation of the yield which is occasioned by the uncertain climate of this country.

Before proceeding to determine the price at which they can be put on the market, it was necessary to ascertain if satisfactory products can be made from English fruit. Generally speaking, English fruit is superior in flavour to that produced in countries not subjected to the same exigencies of climate.

Preliminary experiments on the production of fruit syrups, carried out by Barker and Grove, are described in the Annual Report of the Long Ashton Research Station for 1923. The results they obtained were so encouraging that in accordance with the general arrangement existing between that Station and the Campden Station as regards the development of research on fruit preservation and products in a commercial direction, the investigation was passed on to the present authors for further investigation.

Pressing the Fruit.

The fully ripe fruit was used as soon after picking as possible. It was carefully sorted, and any fruit showing signs of mould rejected. Where the fruit was dirty, it was washed gently in water, but in most cases this was unnecessary. The fruit was then crushed to facilitate pressing. In the preliminary experiments the crushing

was done by hand, but later a power crusher, consisting of revolving wooden fluted rolls, was used. Two types of presses were used: (1) a hand power basket press and (2) a cider press. It was found advisable to sort, wash, and crush the fruit in wooden or earthenware vessels, as contact with metal darkened the colour and also adversely affected the flavour of the juice.

Filtration.

As it flows from the press the juice contains suspended particles of pulp which render it cloudy. These suspended particles are so small that filtration of the juice is rendered somewhat difficult. Cone-shaped flannel filter bags were found satisfactory for the preliminary filtration, but they did not render the juice brilliantly clear. A small plate and frame filter press proved very suitable for filtering the raw juice. The surfaces of the filter cloths were first coated with a layer of keiselguhr and for this purpose a product known as filter-cel was used. Ordinary filter-cel was found to impart an "earthy" taste to the juice, but the special baked quality was found satisfactory and could be mixed with the juice before it was filtered. The best results were obtained by heating the juice before filtering, as in this way most of the proteins were coagulated and removed in the filtration.

Natural Juices.

After filtering, the raw juices were bottled in pint and half-pint bottles and sterilised for twenty minutes at 170° F. On storage, however, some of the bottled juice developed moulds, which were eventually traced to the corks, and was prevented by heating the latter to a temperature of 170° F. prior to use.

Heating was found to be detrimental to the flavour of the juice, particularly when a low natural acidity obtained. Moreover, the colour of the juice was adversely affected by the sterilisation. On the whole, the natural juices were disappointing, being very unpalatable in flavour and rather poor in colour.

Fruit Syrups.

A much better product was obtained by adding sugar to the juice as it ran from the press, or after filtering. Sugar was found to retain the fresh fruit flavour, even after sterilisation, and on storing these syrups retained their colour and flavour for a considerable time. A very satisfactory product was obtained by adding sugar until the juice had a density of about 45 to 50° Balling or, in other words, until the sugar content was 45 to 50% by volume. This

was obtained by adding approximately 7 lbs. of sugar to each gallon of juice. In our experiments syrups were prepared as above, and pasteurised in Winchester quart bottles and ten-gallon glass carboys at 170° F. and were allowed to stand for several weeks. During that time the proteins separated out and the syrup was then carefully syphoned off without disturbing the sediment and filtered through a flannel cone. By this method, elaborate filtration processes were avoided.

The filtered syrup was put up into half-pint and pint bottles, and sterilised at 170° F. for twenty minutes in the same way as the unsweetened product referred to above. Syrups so prepared had a very attractive appearance and an excellent fresh fruit flavour.

Cold Process Fruit Syrups.

Syrups prepared by *saturating* the fruit juice with sugar were also prepared. It was found to be difficult to get the juice saturated quickly with sugar but, by keeping an excess of sugar in the containing vessel and shaking or stirring the mixture every day, saturation was eventually secured. These syrups kept well for a few months, but after lengthy storage slight fermentation was perceptible.

Carbonated Beverages from Fruit Syrups.

Carbonated beverages were prepared from the saturated syrups obtained from red currants, raspberries, loganberries, and black-currants only. These were put up in 7 oz. bottles. A standard $1\frac{1}{4}$ oz. measure—as used in the mineral water industry— was used for measuring the amount of syrup into each bottle. This was made up to 7 ozs. by adding carbonated water and the bottle sealed with a capping machine. These beverages had a very satisfactory flavour and colour, with the exception of red currant, which had a rather pale unattractive colour.

Solids separated out on standing in all cases except chat of the loganberry. Rather better results were obtained when the saturated syrups were filtered. In this case also there was a slight deposition of solids. After being sterilised, no appreciable increase in the amount of precipitate took place.

The 45 to 50° Balling syrup was next used, two fluid ounces of syrup being put into each bottle. The bottles were slightly carbonated and sealed. They were then pasteurised at 165°F. for 30 minutes. Better results were obtained in this case, but slight deposition of solids took place. with the exception of raspberry, which remained clear.

For making bottled carbonated beverages the best results were obtained by using the 45 to 50° Balling syrups, previously pasteurised and allowed to stand for a few weeks. They were then filtered through a flannel cone and made up at once into the carbonated beverages, the latter being at once pasteurised.

General Observations.

So far no attempt has been made to concentrate the juices ; for certain commercial purposes this may be necessary.

The fruits examined were as follows :—

Cherry. Juices were prepared from Black Hearts, Morellos, and May Dukes. The density of the expressed juice varied from 1.05 to 1.062, and the yields from 50 to 63%. The unsweetened juice obtained from Black Hearts was very insipid and poor in flavour, whilst that from May Dukes had a more pronounced Cherry flavour. Much better results were secured when sugar was added to the juices. The juice from May Dukes when saturated with sugar lacked a distinctive flavour, but was superior to that made from Black Hearts. The colour of this juice was also superior to the colour of the juice from Black Hearts. The best result was obtained with juice from Morellos, when its density was raised to 45° Balling by adding sugar. On the whole, cherries did not give very good results. It is possible, however, that cherry juice will be found useful for blending with other juices with higher acidities.

Strawberry. The varieties used were John Ruskin and Paxton. The density of juice obtained was 1.037 and the yield approximately 35%. The juice was poor in colour and flavour, but on the addition of sugar the flavour was improved. The saturated strawberry syrup which had been kept for some months had a more pronounced flavour of the fruit.

Black Currant. On pressing this fruit difficulty was encountered by the juice forming a gel in the bottom of the press. The fruit was, therefore, heated to 140° F. before pressing. In this way the formation of a gel in the press was prevented, but on addition of sugar to the expressed juice a gel formed. It was found advantageous to allow the juice to ferment for three or four days before adding the sugar. Black currant juice alone had a good flavour and colour, both of which it retained during sterilisation and subsequent storage. The density of the juice varied from 1.054 to 1.075 and the yield obtained was approximately 45%. Black currant juice saturated with sugar, and syrup containing about 40% of sugar, have an excellent flavour and colour. The press residue was made into jam of fair quality.

Raspberry. The density of the expressed juice varied from 1.032 to 1.035, and a yield of 60 to 75% was obtained. The acidity of the juice was relatively high and the colour very good. The unsweetened juice after being sterilised and stored for six months was quite unpalatable. The syrups prepared from the juice, however, had excellent flavour and colour.

Loganberry. The density of juice obtained was 1.036 and the yield varied from 53% to 64%. The sterilised juice was very acid and had a good colour, but the flavour rapidly deteriorated on storage. The best results were secured when the crushed fruit was fermented for two or three days prior to pressing. The 45° Balling syrup had a good flavour and colour.

Red Currant. The density of the expressed juice was 1.035, which on subsequent pasteurisation was reduced to 1.030 and 1.021, and the yield was approximately 45%. The unsweetened juice became very acid and unpalatable on keeping, but good results were obtained when this juice was made into 45° Balling syrup. A good colour was obtained as well as an excellent flavour. This was one of the best of the series.

Blackberry. The density of the juice varied from 1.029 to 1.036 and the yield from 55 to 60%. Unsweetened juice did not retain its flavour on storing. The 45° Balling syrup made with this juice did not possess a very pronounced flavour and the juice saturated with sugar also lacked distinctive flavour. It was found advisable to ferment the crushed fruit for three days before pressing in order to avoid gel formation; to facilitate the fermentation, a little sugar was added to the fruit.

Too much importance must not be attached to the percentage yields of juice obtained in these experiments. It is obvious that this depends on the type of press used, as well as the condition of the fruit. The same, of course, may be said of the densities of the individual fruit juices, which in the above cases were determined at 60° F.

Summary.

1. On the whole the flavour of the raw juices was disappointing.

2. The best results were obtained by adding sugar until the density of the syrups was 45 to 50° Balling.

3. The syrups made from black currants, raspberries, loganberries and red currants were excellent.

THE EFFECT OF SUGAR, ACID, AND "SET" ON THE KEEPING PROPERTIES OF JAMS.

By F. Hirst.

Jams are not generally put up in airtight containers. In common practice they are marketed in glass or porcelain jars, the top of which is covered with parchment paper. Recently, metal covers have been introduced, but these are not intended to be absolutely airtight, as good jam is expected to keep for an appreciable time even after it has been opened. The only preserving agent used is sugar, and the question often arises as to what percentage of sugar is necessary to ensure jam keeping. The natural acid found in the fruit may also have a slight preserving effect.

When jam deteriorates, it is generally due to the growth of moulds, or in some cases due to fermentation of the sugars which arises through the presence of yeasts. The following experiments have been carried out to ascertain :—

1. What sugar concentration is necessary to prevent fermentation and mould growth.
2. The inhibiting effect of acid on the growth of yeasts and moulds.
3. Whether the "set" of the jam plays any part in preventing fermentation.

There does not appear to be much information available on these questions. Grove (1) states that yeasts and bacteria do not develop in a sugar solution of 50% or more, or in a solution containing 45% sugar if the acidity is 1.2%. On the other hand, he found that moulds would grow in a 65 to 70% sugar solution.

In the preliminary experiments, sugar solutions were prepared containing varying proportions of sugar. Several substances were tried as a source of nitrogen : 2% malt extract was found to be the most suitable and was afterwards used in all the solutions. The percentages of sugar added varied from 50% to 70%. The solutions were poured into honey pots with screw caps and were sterilised for 20 minutes at boiling temperature. Separate samples were inoculated with :—

(*a*) Wild yeast isolated from a fermenting sample of cold process jam.

(*b*) The common blue mould *Penicillium Glaucum*.

In the next series, similar solutions were prepared, but in one case 0.5%, and in the other case 1% of tartaric acid was added. The samples were incubated at 22° C. An examination of the solutions was made periodically, and the results are shown in the following table.

(1) O. Grove. Annual Report of the Agricultural and Horticultural Research Station, Long Ashton, Bristol, 1918.

% of Sugar	50.0	52.5	55.0	57.5	60.0	62.5	65.0	67.5	70.0
No acid present.									
Remarks :	Fermenting after 9 days	Fermenting after 9 days	Fermenting after 9 days	Fermenting after 10 days	Fermenting after 10 days	Fermenting after 13 days	Fermenting after 13 days	Fermenting after 13 days	Fermenting slightly at the surface after 32 days.
	Mould growth after 8 days	Mould growth after 8 days	Mould growth after 10 days	Mould growth after 11 days	Mould growth after 11 days	Mould growth after 14 days	Very slight Mould growth after 30 days	No mould growth after 4 months	No mould growth after 4 months
0.5% Tartaric acid added.									
Remarks :	Fermenting after 11 days	Fermenting after 11 days	Fermenting after 11 days	Fermenting after 13 days	Fermenting after 13 days	Fermenting after 19 days	Fermenting after 26 days	Fermenting after 30 days	Fermenting slightly at the surface after 32 days.
	Mould growth after 8 days	Mould growth after 8 days	Mould growth after 11 days	Mould growth after 11 days	Mould growth after 11 days	Mould growth after 14 days	Slight mould growth after 30 days	No mould growth after 4 months	No mould growth after 4 months.
1% Tartaric acid.									
Remarks :	Fermenting after 30 days	Fermenting after 60 days	Fermenting after 60 days	Fermenting after 60 days	Fermenting after 60 days	Fermenting after 70 days	Fermenting slightly at the surface after 3 months	Fermenting slightly at the surface after 3 months	Not Fermenting after 3 months
	Mould growth after 8 days	Mould growth after 8 days	Mould growth after 14 days	Mould growth after 14 days	Very slight mould growth after 14 days	Very slight Mould growth after 14 days	Slight mould growth after 3 months	No mould growth after 4 months	No mould growth after 4 months

It will be seen that in the first series all the solutions fermented within 33 days. Mould growth was observed in the solutions containing from 50% to 65% sugar within 30 days, but there was no growth in the other cases after four months. From the above experiment it is apparent that a 70% sugar solution will ferment. Jams generally contain from 60% to 70% sugar, but with 70% sugar there is a danger of crystallisation, more so if the jam has been prepared from a very acid fruit. From the above results 67.5% sugar appears to be necessary to prevent mould growth in sugar solutions.

The addition of 0.5% acid did not appear to have any appreciable effect either on the development of yeast, or on the growth of Penicillium. When the acid was increased to 1%, fermentation occurred in all the solutions with the exception of the one containing 70% sugar, but it did not appear to have any serious inhibiting effect on the growth of Penicillium.

In the next series of experiments, pectin gels were prepared containing varying amounts of pectin in order to obtain variation in the " set " of the jellies. As it is impossible to get a pectin gel without acid, two series were prepared : the first containing 0.5% tartaric acid, and the second 1% tartaric acid. It was not possible in all cases to get the yeast cells incorporated into the jelly when inoculating, as the jellies set at too high a temperature. The jellies were therefore inoculated with yeasts at a temperature of 25° C. by plunging a sterile platinum wire into a fermenting sugar solution, and then plunging it into the jellies at two or three points. The surface of the jellies were inoculated with the spores of *Penicillium Glaucum*. The results are tabulated below.

Sugar Grams	Acid Total	Malt Extract Grams	Pectin Grs. of a 4% soln	Water Grams	Boiled out weight	Type of set	Remarks.
	%						
50	0.5	2.0	6	46.5	100	Not set	Fermenting after 12 days; mould growth after 8 days.
50	,,	,,	10	42.5	,,	Weak	do. do.
50	,,	,,	15	37.5	,,	Good	do. do.
50	,,	,,	20	32.5	,,	V. Good	do. do.
55	,,	,,	6	41.5	,,	V. Weak	do. do.
55	,,	,,	10	37.5	,,	Weak	do. do.
55	,,	,,	15	32.5	,,	Good	Fermenting slowly after one month; mould growth after 12 days.
55	,,	,,	20	27.5	,,	V. Good	Gas bubbles visible where inoculation had taken place after 1 month; mould growth after 12 days.
60	,,	,,	6	36.5	,,	Weak	Fermenting after 1 month; mould growth after 12 days.
60	,,	,,	10	32.5	,,	Good	Fermenting after 50 days; small patch of mould growth after 2 months.
60	,,	,,	15	27.5	,,	Good	do. do.
60	,,	,,	20	22.5	,,	V. Good	Fermenting slightly near the surface and mould growth after 2 months.
65	,,	,,	6	31.5	,,	Weak	Fermenting after 50 days; mould growth after 2 months.
65	,,	,,	10	27.5	,,	Good	Fermenting slightly after 3 months, slight mould growth after 3 months.
65	,,	,,	15	22.5	,,	V. Good	No fermentation or mould growth after 3 months; thin layer of sugar formed on surface.
65	,,	,,	20	17.5	,,	V. Good	do. do.
70	,,	,,	6	26.5	,,	V. Good	Slight fermentation near surface after 3 months; sugar crystals also separating out.
70	,,	,,	10	22.5	,,	Weak	do. do.
70	,,	,,	15	17.5	,,	Good	No fermentation or mould growth after 3 months.
70	,,	,,	20	12.5	,,	Good	do. do.

It will be seen that there is a marked difference between the results in the sugar solutions and in the pectin gels, especially so in the case of fermentation. In the well-set pectin jellies containing 65% sugar and 0.5% acid there was no fermentation after three months. In weak set jellies there was fermentation in the jellies containing up to 70% sugar. The highest concentration on which mould growth appeared was 65%.

Sugar Grams	Acid Total	Malt Extract Grams	Pectin Grs. of a 4% soln	Water Grams	Boiled out weight	Type of set	Remarks.
	%						
50	1	2	6	46	100	Not set	Fermenting after one month; mould growth after 9 days.
50	1	2	10	42	„	Weak	do. do.
50	1	2	15	37	„	Good	do. do.
50	1	2	20	32	„	V. Good	do. do.
55	1	2	6	41	„	V. Weak	do. do.
55	1	2	10	37	„	Weak	do. do.
55	1	2	15	32	„	Good	Fermenting slightly after 1 month; mould growth after 8 days.
55	1	2	20	27	„	Good	Fermenting after 1 month; mould growth after 8 days.
60	1	2	6	36	„	Weak	Fermenting after one month; mould growth after 12 days.
60	1	2	10	32	„	Fair	Fermenting after 1 month; mould growth after 3 months.
60	1	2	15	27	„	Good	Not fermenting after 3 months; mould growth after 3 months.
60	1	2	20	22	„	V. Good	do. do.
65	1	2	6	31	„	Weak	Fermenting slowly, and mould growth after 3 months.
65	1	2	10	27	„	Fair	do. do.
65	1	2	15	22	„	V. Good	No fermentation or mould growth after 3 months; a thin layer of sugar formed on the surface.
65	1	2	20	17	„	V. Good	do. do.
70	1	2	6	26	„	V. Weak	No fermentation or mould growth after 3 months; a layer of sugar had formed on the surface and crystals were separating out in the jelly.
70	1	2	10	22	„	Weak	do. do.
70	1	2	15	17	„	Good	No fermentation or mould growth after 3 months.
70	1	2	20	12	„	Good	do. do.

With 1% acid, the results were very similar. The 70% jelly with a weak set did not ferment, whereas with 0.5% acid there was fermentation in the corresponding jelly. The acid does appear to have a slight effect on the growth of yeast, but in the strength used it has no appreciable effect on the growth of Penicillium. The "set" of the jelly, however, appears to be a very important factor in preventing fermentation.

Jams were next prepared from Plum Pulp. The latter was prepared from fresh fruit and put up in vacuum bottles and sterilised. It was used about six months after being put down. The samples were inoculated with wild yeasts only.

Sugar.	Plum Pulp	Boiled out weight	Type of set	Remarks.
60.	45.0	100	Not very good	Fermentation after 7 days, and the fermentation spread rapidly into the body of the jam.
62.5	42.5	100	do.	Fermenting after 21 days, but only on the surface.
65.0	40.0	100	do.	do.
67.5	37.5	100	do.	Fermenting very slightly after 1 month. No worse after two months, but sugar crystallising out.
70.0	35.0	100	do.	do.

The acidity of the jam varied with the amount of pulp used, that of the 65% sample was 0.5% calculated as tartaric acid. The above experiment was repeated using plum pulp which was more concentrated and consequently gave a better set. The 60% and 62.5% samples fermented very slightly on the surface; the 65% was not fermenting after three months. The 67.5% and the 70% jams were not fermenting, but were beginning to crystallise after three months incubation.

Jams were also prepared from Damson Pulp, and very similar results were obtained.

The experiments show that the keeping property of jam depends on three factors: sugar, acid, and the "set." The latter appears to play an important part in preventing fermentation. In a well-set jam, it is difficult for the yeasts to get into the body of the jam, and jams prepared here containing only 60% sugar, but with a good set, have kept for over a period of twelve months and have shown no signs of fermentation. From the above results, however, it is apparent that 65% sugar is necessary to prevent slight fermentation if wild yeasts gain access to the jam. The prevention of mould growth is a more difficult problem. In the experiments above, *Penicillium Glaucum* did not grow when the sugar content was 65%, or over. On the other hand, samples of jams from all the boilings prepared at the Research Station during the past three years have been stored, and some samples containing 65% sugar and over have developed *Penicillium Glaucum* when stored in a damp atmosphere. Jams containing over 65% sugar are too sweet, but apart from that they tend to crystallise when stored, more so if they are prepared from the more acid fruits.

On comparing the results here recorded on the relation between sugar concentration and keeping quality with those obtained by

Grove (1) it should be mentioned that the conditions of experiment differed in the two cases in two important particulars. Firstly, the receptacles used by Grove as containers for the solutions under test were not sealed down in any way, the mouths being merely plugged with cotton wool. This arrangement obviated any risk of condensation of water vapour on the surface of the concentrated sugar solution and the consequent dilution of sugar strength at that point ; on the other hand owing to gradual loss of water vapour through the cotton wool plug the strengths of the solutions under trial would tend to increase gradually during the course of the experiments, although possibly not sufficiently in the relatively short period of the trials to alter the stated strength very materially. In the Campden experiments on the other hand the solutions, gels and jams were kept in containers closed with screw caps, the result being a tendency for condensed water vapour to settle on the surface of the material under trial and dilution of the stated strength to occur at that point. The recorded results indeed show the beginning of fermentation and mould growth to take place there. Hence the strengths of sugar content stated do not probably apply to the superficial layer of material in the pots during the actual experiment for appreciable superficial dilution must have occurred from moisture condensation there on cooling after the sterilisation process. Secondly, Grove used for infection purposes yeasts which had previously been growing under conditions of comparatively low sugar concentration, whereas in the present investigation the infection material was taken from media of a very high sugar concentration. The sudden extreme change in the osmotic character of the medium in the former case may have resulted in the growth of the yeast cells being completely arrested, while in the latter case they may already have become acclimatised to growing under conditions of high sugar concentration in the sample of fermenting jam from which they were taken.

There is the further possibility that in the former case the kinds of yeasts used chanced to be sorts which cannot under any conditions tolerate a high sugar concentration, a point which obviously does not apply to the latter case.

Thus the Campden results and those of Grove are not necessarily contradictory. Rather they show the importance of the method under which jams, gels and syrups are stored. The very high sugar concentrations are clearly required under conditions which permit of moisture condensation in the surface of the material such as occur during storage in damp places or situations with widely varying temperature or in containers sealed with metal caps or covers relatively impermeable to moisture vapour ; whereas under the opposite type of conditions appreciably lower concentration of sugar will probably suffice to restrict fermentation or mould growth.

EXPERIMENTS ON THE PRESERVATION OF TOMATOES.

By A. Appleyard and F. Hirst.

The annual production of glass-house Tomatoes in the Lea Valley is approximately 40,000 tons. The fruit is carefully graded before packing and in the grading small tomatoes known as "chats," along with the fruit which is split or irregular in shape, is separated. It is estimated that about 1,500 tons of " chats " and " splits " are marketed at prices which are not remunerative to growers.

Experiments have been carried out to ascertain if this fruit could be utilised for canning or for making into Tomato products. If the lower grade fruit were not disposed of on the fresh fruit market, there is a possibility that better prices for the higher grades would be secured.

The tomatoes for these experiments were kindly supplied by H. C. Larsen, Esq., Nurseryman, Waltham Abbey. All the boxes of " chats " sent arrived in excellent condition. The split fruit, however, was found to be very badly moulded and in some cases the mould had penetrated well into the fruit, the necessary trimming thus causing considerable waste. Canned tomatoes, tomato chutney, and tomato sauce were made from the fruit supplied. These products were in all cases excellent and have sold very readily.

Canned Tomatoes.

The following methods were used in the canning of tomatoes.

1. The tomatoes were washed and placed in a blanching basket, the basket then being dipped into boiling water for one minute to loosen the skins and facilitate peeling. The skins were removed and the fruit placed in a pan and gently simmered for ten to fifteen minutes. No liquid was added. The tomatoes were then packed into English No. 1 and No. 2 cans. These were filled up with the liquid which had drained from the fruit and then immediately closed with a Bliss can-seaming machine. Heating No. 1 cans for 20 minutes, and No. 2 cans for 30 minutes at 212° F. was found adequate to effect sterilisation.

2. The tomatoes were graded and peeled as above. They were then packed into the cans and the latter were filled up with tomato pulp which had been prepared by boiling down the split fruit. The cans were sealed and sterilised as before.

3. Small chats were washed, graded, and packed into English No. 1 cans and the latter at once filled up with hot brine ($2\frac{1}{2}$ ozs. salt per gallon of water) and sealed. Heating the cans for 30 minutes in boiling water sufficed to destroy infecting organisms.

Tomato Sauce.

Spiced Vinegar was made by using the following ingredients :—

1 gall.	Distilled Vinegar.
2 ozs.	Cinnamon Bark.
2 ozs.	Allspice.
2 ozs.	Penang Clove Stalks.
$1\frac{1}{2}$ ozs.	Mace.

The spices were added to the vinegar and the latter brought to the boil. The mixture was allowed to infuse for two hours and then strained through muslin.

Ninety-six pounds of tomatoes were cooked in an aluminium jam pan until soft enough for pulping. They were then put through a hand pulping machine, the sieve of which was made of monel metal. The pulp was then put back into the jam pan and cooked to a thick purée. The ingredients in the proportions indicated below were found to give the best results. These, along with the strained spiced vinegar, were added to the pulp and the whole was again cooked with constant stirring until it had the consistency of thick cream. The sauce was poured hot into 8 oz. sauce bottles, which were heated at 170° F. for 30 minutes.

8 lbs.	Sugar.
12 ozs.	Salt.
2 ozs.	Paprika Pepper.
16 ozs.	(fluid) Tarragon Vinegar.
1 gram	Cayenne Pepper.

Tomato Chutney.

The tomatoes were peeled as described above under canning, and boiled down to a thick pulp. The strained spiced vinegar and the ingredients mentioned under Tomato Sauce were then added. Better results, however, were secured by increasing the sugar

content by 50%, *i.e.*, by using 12 lbs. instead of 8 lbs. The mixture was cooked again to a thick consistency and bottled hot. In these experiments the bottles were sealed by means of the Phoenix Cap and vinegar-proof papers were inserted between the cap and the chutney.

In making Tomato Sauce and Chutney it was found advisable to use boiling pans, pulpers, etc., made from a metal which would not be attacked by the acid in the fruit. The copper vessels were readily attacked by the acid and the colour of the product was detrimentally affected. Satisfactory results were obtained by using an aluminium pan and a pulper made of monel metal.

Samples of these products, and cost of raw materials only in respect of such products, were sent to the Lea Valley Growers' Association, along with a report of plant, etc., required for commercial scale operations.

THE PRESERVING QUALITIES OF DIFFERENT VARIETIES OF FRUIT AND VEGETABLES.

Canning and Bottling Trials:
(2) Peas.

By F. Hirst.

The preservation of green peas is a considerable industry in France and the United States. In both these countries varieties have been carefully tested for their suitability for Canneries. By request, a number of varieties have been grown in the experimental grounds at Campden, and their suitability for canning or bottling determined.

In France and the United States, the green peas suitable for canning are harvested over a period of two to three months, early, middle early, and late varieties being grown to extend the period of the canning operations as much as possible.

The varieties mentioned below were grown at Campden during the last two seasons. During the 1926 season there was a long spell of dry weather and the peas ripened quickly, with the result that many of them were corny, and the flavour was poor. It was also noticed that peas which had become corny tended to become cloudy after processing. This was especially the case with large peas. The experiments showed that the covering liquid always remained clear after processing and storage when small peas picked at the right stage of maturity were used.

The green pods were harvested, weighed and shelled, and the percentage of shelled peas on the weighed pods was determined. The shelled peas were then graded through the No. 24, 27, and 29, *i.e.*, 7 mm., 8 mm. and 9 mm. standard French pea sieves.

The grains passing through the number 29 sieve and those which were too large to pass through were blanched for three minutes in boiling water, whilst the smaller sizes were blanched for two minutes. The peas were then filled into cans and bottles and covered with a solution prepared by dissolving $2\frac{1}{2}$ ozs. of salt, and $2\frac{1}{2}$ ozs. of sugar per gallon of water. The containers held approximately 8 ozs. of peas, and after sealing they were processed for half an hour at 240° F., in an autoclave.

It will be seen from the table which is appended that the best results were as follows :—

1.	Small Peas ..	Alaska ; Chemin Long No. 4 ; Annonay ; Gontier Blanc.
2.	Medium Sized Peas :	Bountiful ; Scimitar ; Advancer ; Delicatesse.
3.	Large Peas ..	Lincoln ; Prince of Wales ; Gradus ; Yorkshire Hero.

Further trials are being carried out, using higher concentrations of sugar in the covering liquid.

Peas grown for canneries should ripen uniformly so that they can be cut by machinery. Further experiments are necessary to determine which varieties are the best from this point of view.

I am indebted to Messrs. Johnson's of Boston, Lincolnshire, for supplying the seed for these experiments.

Variety.	Description.	Colour. Appearance.	Flavour.
Alaska ..	2½ ft. A first early, pale green haulm and pea. The latter is blunt ended. Prolific.	Small pea, good colour.	Good.
Bountiful ..	3 ft. Very heavy cropper, early, light coloured pointed pods.	Small to medium sized pea.	Good.
Chemin Long No. 4.	2½ ft. French variety, favoured for canning purposes, abundant cropper, pale pods.	Small pea, good colour.	Good.
Scimitar ..	4 ft. Second early, medium green pods, used on the Continent by Canning Companies because it is a very heavy cropper, and matures uniformly	Small to medium size pea, fair colour.	Good.
Advancer ..	2 ft. Robust grower, pods in pairs, second early.	Medium size, good colour.	Good.
Prince of Wales	3 ft. An exceptional heavy cropper, pods rather small and pale, maincrop variety.	Large pea, colour fair.	Good.
Gradus ..	3 ft. A most deservedly popular large podded early variety, pods are pointed and of medium dark green colour.	Large pea, colour fair.	Good.
Lincoln ..	1½ ft. Very sturdy in habit, pods pointed dark green, a second early maincrop variety with rich dark green haulm, requires little or no sticking.	Medium to large pea, fair colour.	Good.
Annonay ..	2 ft. Second early dwarf, very prolific cropper.	Small pea, fair colour.	Good.
Gontier Blanc	1 ft. Early maincrop, small pointed pods, heavy cropper.	Small pea, fair colour.	Good.
Yorkshire Hero	2½ ft. Of extra ordinary quality, maincrop, and although rather small podded is a heavy cropper, medium light coloured pods, blunt ended.	Very large pea, fair colour.	Good.
Delicatesse ..	2½ ft. Second early maincrop variety. Pods are stump ended, rather pale in colour. Dark haulm, very vigorous.	A medium to large pea, fair colour.	Good.
Johnson's "Magnificent"	2½ ft. Medium late cropper, very productive, large blunt ended pea, vigorous habit.	Very large pea, rather dark in colour.	Fair.
Johnson's "The Victor"	2½ ft. One of the largest seeded varieties in existence. Maincrop, produces many pods in pairs, sturdy habit, large pointed pods, rich dark green colour.	Very large pea of fair colour.	Fair.

Variety.	Description.	Colour. Appearance.	Flavour.
Johnson's "The Leader"	3 ft. Medium coloured haulm and pod, prolific. Pods are pointed.	Large pea of fair colour.	Fair.
Johnson's "Super Telegraph"	4 ft. Medium late variety, practically all pods come in pairs. The latter are large, medium green in colour and pointed. A very popular second pea for market work.	Large pea of fair colour.	Fair.
Johnson's "New Glory"	3 ft. An extra fine market variety for pulling green. Produces a much finer pod, gives a considerably larger yield and is larger seeded than "Harrison's Glory."	Very large pea, rather dark in colour.	Fair.
Fillbasket ..	2½ ft. Early maincrop, very useful market sort, sturdy and a heavy cropper.	Fair colour.	Fair.
Beck's ..	1 ft. Very early, very prolific, pods in pairs, small well filled, a useful frame variety.	Fair colour.	Fair.
Thomas Laxton	3 ft. Early, an excellent market variety yielding a heavy crop of fairly large blunt ended pods.	Fair colour.	Fair.
British Lion ..	2½ ft. Early prolific, small pointed pods, medium light green coloured foliage.	Fair colour.	Fair.
Blue Peter ..	1 ft. An early small blunt podded variety, very prolific.	Small pea of good colour.	Fair.
The Pilot ..	2½ ft. First early, a large pointed podded variety.	A medium sized pea.	Fair.
Senator ..	2½ ft. An early maincrop, good cropper. Habit sturdy, pods pale green, curved and pointed.	A large pea of good colour.	Fair.
Telegraph ..	5 ft. A second early maincrop, producing large dark green pointed pods, several pairs.	A fairly large pea, colour poor.	Fair.
Kenilworth ..	4 ft. Second early, small, medium green coloured pointed pods, very prolific.	Medium sized pea.	Fair.
Laxton's Suberb	2 ft. Second early maincrop, medium dark green curved pointed pod.	A large pea, rather dark in colour.	Fair.

Variety.	Description.	Colour. Appearance.	Flavour.
Market Surprise	2½ ft. First early, rather small pointed pods. An extra-ordinary yielding variety. Pods are mostly borne in pairs.	Good sized pea of good colour.	Poor.
Mammoth Extra Early	3 ft. Early, heavy cropping variety, producing fairly large, light coloured, blunt ended pods.	Medium sized pea, fair colour.	Poor.
Michaux de Hollande	3 ft. Second early, sturdy variety, producing medium size blunt ended pods. Prolific cropper.	Good size pea of good colour.	Fair.
Sharp's Unique	First early, hardy robust and bushy. Pods in pairs. Very prolific. This variety fills very quickly, and can be pulled 8 to 10 weeks from time of sowing.	Very yellow in colour.	Fair.
Petit Provencial	1 - 1½ ft. Early, heavy cropper, dark foliage, and dark green blunt pods.	Medium size, good colour.	Fair.
Harrison's Glory	2½ ft. Maincrop, a most useful "Blue boiling pea," often referred to as "Marrowfat," in the dry seed state. Large pointed pod, very productive.	Very large pea, rather dark in colour.	Poor
Pride of the Market	2 ft. A prolific second early, fine podded variety.	A fairly large pea.	Poor.
Gladiator ..	2½ ft. Early maincrop, medium green pointed pods.	Good size, tend to become cloudy after storage.	Poor.
Sunrise ..	2½ ft. Very hardy, early, prolific, small podded variety.	Medium sized pea.	Poor.
English Small Blues	4½ ft. Second early, medium light green luxuriant foliage, with small narrow slightly pointed pods. Prolific.	Small peas, rather yellow.	Poor.
Maximum ..	2 - 2½ ft. Heavy cropper, canning variety, but considered too coarse and too heavy in haulm, and for this reason is not desirable. Many superior varieties on the market.	Poor colour.	Poor.
Sangster's ..	2½ ft. Very early, rather light green pods. Prolific cropper.	Small pea, good colour.	Poor.

PRELIMINARY REPORT ON LACQUER TESTS.

By F. Hirst and W. B. Adam.

The retention of the colour of soft fruits such as raspberries, loganberries, black currants, etc., after they have been canned, depends very largely on the lacquer with which the inside of the can is coated.

Following several enquiries as to the necessity or otherwise of double lacquering, experiments have been carried out in collaboration with the lacquer manufacturers and the can makers.

The following lacquers were tested :—

1. Standard Zinnatine, stoved to a temperature of 310° for $2\frac{1}{2}$ hours.
2. Standard Zinnatine, with the insides double lacquered by spraying the tins inside after making up, both stovings having been undertaken at 310° F. for $2\frac{1}{2}$ hours.
3. Super Zinnatine, stoved at a temperature of 310° F. for $2\frac{1}{2}$ hours.
4. Super Zinnatine (double lacquered), the second coat having been applied by spraying after making up, the stoving of both coats having been effected at a temperature of 310° F. for $2\frac{1}{2}$ hours.

The tins were lacquered in the ordinary way by Messrs. Williamson and Sons, Ltd., Providence Works, Worcester.

The following fruits were canned to find the action of fruit acids on the different lacquers : gooseberries, five varieties of rhubarb, Victoria Plums and Tomato Purée. The appended Table I. gives the results obtained. It will be noticed that with rhubarb, the single lacquers were very badly attacked ; the double lacquers were very good, double Super Zinnatine showing no signs of penetration. It is quite clear from these results that for the canning of rhubarb it is necessary to use a can double lacquered with Super Zinnatine.

The following coloured fruits were also processed in cans treated as above : raspberries, loganberries, black currants, red currants,

damsons and strawberries. In canning these fruits it has been noticed that wherever tin is exposed, it has a bleaching action on the fruits. Raspberries are bleached considerably, and also take on a bluish tinge. Loganberries tend to become purple in colour, and the syrup becomes very cloudy. With black currants the fruit and syrup take on a blue instead of a natural purple colour, and this is also the case with damsons. To get over this difficulty, many of the canners add artificial colours to their syrup during the canning operations. From the appended Table II. it will be noticed that double lacquering prevents this discoloration, particularly so where Super Zinnatine is used. These results show that with double lacquering, particularly with double Super Zinnatine, it is unnecessary to use colouring matter.

TABLE I. EFFECT OF ACIDITY.

Fruit	Type of Lacquer	Date when Processed	Quantities Used: Fruit	Quantities Used: Syrup	Quantities Used: Syrup Strength	Date when Opened	Vacuum and Filling.	Appearance of Fruit and Syrup	Appearance of Lacquer	PH (Colorimetric)	Acidity As Malic Acid (Indicator)	Remarks
Gooseberries	Standard Z.	22/6/27	lbs. ozs. 1 2	ozs. 13	per gal. 5-lb.	1/12/27	vac. 6-in. Well filled	Syrup rather cloudy	Scratched and speckled	3.1	0.95%	Super Z D much the best. Fruit in excellent condition, & no sign of penetration of the lacquer
	Stan. Z.D.						8-in. do.	do.	Good	3.0	0.99	
	Super Z.						7-in. Slight space	do.	Scratched and speckled	3.0	0.96	
	Super Z.D.						7-in. do.	Syrup clear	Good	3.0	1.05	
Rhubarb .. (Solid Pack) Champagne	Standard Z.	16/5/27	1 6	8	4lb.	9/12/27	6-in. Well filled	Fruit & Sryup colourless Syrup cloudy	Very bad. Peeled off almost entirely	3.3	0.77%	Super Z D preserved the colour excellently. The lacquer in this case was not attacked
	Stan. Z.D.						6½in. do.	Fruit & Syrup pink	Satisfactory	3.3	0.81	
	Super Z.						7-in. do.	Fruit & Syrup colourless Cloudy	Very bad. Peeled off and speckled	3.3	0.77	
	Super Z.D.						— Full	Fruit & Syrup bright pink Clear syrup	Very good	3.3	0.89	
Rhubarb .. (Solid Pack) Victoria	Standard Z.	25/5/27	1 6	8	4-lb.	1/12/27	8-in. All well filled	All practically colourless. Syrups clear	Very bad	3.1	1.06%	The appearance of the fruit was much the same in each case, but only in the Super Z D was the lacquer intact
	Stan. Z.D.						6½in.		Fair (edges slightly attacked)	3.2	1.08	
	Super Z.						5-in.		Poor	3.2	1.05	
	Super Z.D.						7-in.		Good ; not scratched or attacked	3.1	1.08	
Rhubarb .. (Solid Pack) Dawes Champion	Standard Z.	26/5/27	1 6	8	4-lb.	9/12/27	5-in. Well filled	Fruit & Syrup colourless	Very badly peeled & speckled	3.1	1.03%	Similar results to "Champagne"
	Stan. Z.D.						6-in.	Fruit & Syrup pale pink	Slightly peeled round seams	3.1	1.07	
	Super Z.						6-in.	Fruit & Syrup colourless	Slightly peeled ; very badly speckled	3.1	1.07	
	Super Z.D.						7-in. Very well filled	Fruit & Syrup bright pink	Good	3.2	1.09	
Rhubarb .. (Solid Pack) Prince Albert	Standard Z.	23/5/27	1 6	8	4-lb.	9/12/27	5-in. Well filled	Pale green colour All syrups clear	Practically all lacquer off	3.2	1.10%	Similar to "Victoria"
	Stan. Z.D.						4-in.		Good ; seams slightly peeled	3.2	1.09	
	Super Z.						4-in.		Slightly peeled. Badly speckled	3.2	1.13	
	Super Z.D.						— Full		Very good	3.2	1.05	
Rhubarb .. (Solid Pack) Sutton's Seedless	Standard Z.	26/5/27	1 6	8	4-lb.	9/12/27	4-in. All well filled	Fruit & Syrup colourless	Badly peeled at base ; poor on sides	3.1	1.36%	Similar to "Champagne"
	Stan. Z.D.						5-in.	Fruit & Syrup pale pink	Good ; faintly speckled near seam	3.1	1.30	
	Super Z.						5-in.	Fruit & Syrup colourless	Slightly peeled ; very badly speckled	3.1	1.30	
	Super Z.D.						4-in.	Fruit & Syrup pale pink	Very good	3.1	1.29	
Tomato Puree	Standard Z.	7/9/27	1 14	—	—	1/12/27	5½in. Well filled	Fair appearance	Rather scratched and speckled	4.2	0.63%	Both double lacquered cans gave quite good products
	Stan. Z.D.					9/12/27	5½in.	Satisfactory	Good ; slighly attacked near seams	4.2	0.66	
	Super Z.					do.	4-in.	Fair	Speckled & slightly peeled	4.2	0.62	
	Super Z.D.					do.	4-in.	Satisfactory	Very good	4.2	0.62	
Victoria Plums	Standard Z.	8/9/27	1 5	12	6-lb.	1/12/27	5-in. All well filled	Syrup pale colour ; faintly purple	Scratched ; peeled off slightly	3.2	0.83%	The Super Z D gave much the finest product. The colour was well preserved
	Stan. Z.D.						6-in.	Fairly good colour	Scratched slightly	3.2	0.93	
	Super Z.						4-in.	Syrup rather pale ; purple tint	do.	3.2	0.94	

Table II.

Retention of the Natural Fruit Colours.

Fruit	Type of Lacquer	Date when Processed	Quantities Used			Date when Opened	Vacuum and Filling	Appearance of Fruit & Syrup.	Appearance of Lacquer	Remarks
			Fruit	Syrup	Syrup Strength					
Raspberries	Standard Z. Stan. Z.D. Super Z. Super Z.D.	12/7/27	lbs. ozs. 1 2	ozs. 16	Per gal. 10-lbs.	1/12/27	Vac. 10-in. Quite well filled 8-in. Quite well filled 9-in. Quite well filled 10-in. Very well filled	Slightly bleached Good colour Slightly bleached Very deep rich colour	Slightly scratched and peeled Some scratches ; no peeling Scratched ; slight signs of peeling Good. Faint scratches through	Both double lacquers were good. The "super" was better than "standard" in each case. Super Z.D. gave a perfect product without any added dye
Loganberries	Standard Z. Stan. Z.D. Super Z. Super Z.D.	21/7/27	1 0	17	10-lbs.	1/12/27	7-in. 9-in. 6½-in. Good 6½-in.	Berries bleached ; cloudy syrup Good colour berries ; clear syrup Berries rather bleached ; cloudy syrup Very fine colour. Syrup clear	Deep scratches ; few patches Faint scratches peeled Scratches ; slight peeling ; rather speckled Very good	Similar results were obtained with rasps and logans. Super Z.D. excellent
Black Currants	Standard Z. Stan. Z.D. Super Z. Super Z.D.	29/7/27	1 2	14	10-lbs.	1/12/27	10-in. 10-in. 10-in. 9-in. All well filled	Syrup deep purple colour Syrup deep red Purple colour noticeable Deep red syrup	Deeply scratched and speckled Satisfactory Very deeply scratched and speckled Very good	The "purpling" of the single lacquered samples was most noticeable
Red Currants	Standard Z. Stan. Z.D. Super Z. Super Z.D.	13/7/27	1 2	13	10-lbs.	9/12/27	8-in. Quite well filled 7½-in. do. 8-in. do. 8-in. Well filled	Fruit pale ; syrup purple tint Fruit rather pale ; syrup pink Fruit very pale ; pink syrup ; purple tint Fruit good colour ; bright red syrup	Slightly scratched and peeled Satisfactory Very slightly scratched and peeled Very good	The advantage of using Super Z.D. is most noticeable in the bright colour of the syrup
Damsons	Standard Z. Stan. Z.D. Super Z. Super Z.D.	14/9/27	1 4	12	6-lbs.	9/12/27	5½-in. 5½-in. 4-in. 4-in. Well filled	Syrup and fruit rather purple Syrup and fruit red-purple Syrup and fruit slightly purple Syrup and fruit natural deep red	Good. Very slightly peeled Very good Good Very good	All samples were good. But the Super Z.D. was the only one free from the deep purple tint
Strawberries	Standard Z.D. Super Z.D.	19/7/27	1 2	13	10lbs.	9/12/27	7-in. 8-in. Well filled	Very poor colour Poor colour ; better than Standard Z.D.	Very good Very good	Sound lacquering is no protection against loss of colour in strawberries

THE RAISING OF BASKET WILLOWS FROM SEED.

By H. P. Hutchinson.

The fact that willows grow readily from cuttings, accounts for the adoption of this vegetative method of propagation in commercial practice. Hence the variety characters of willows as a rule remain constant. Variations always occur as effects due to differences in the soil conditions under which any variety may be grown and "sports" occasionally are produced. The selection and propagation of "sport rods" is the origin of "new varieties" which, under new names, have come into commercial cultivation. These "sport varieties" do not possess characters superior to those possessed by the original stocks, nor are their characters fixed; they are prone to reversion, producing rods indistinguishable from those of the varieties from which they originally arose. Hybrid varieties of basket willows exist, but these with the exception of the variety—Mawdesley—are not extensively grown. The four hybrid varieties in the Station's collection have not shown reversion to any original type after many years of continuous cropping.

It is the generally accepted view of Botanists that willows hybridise freely. Cross fertilisation takes place in the species, but in nature, although seed is copiously produced, seedling willows are rare. Willow seed is small and short-lived, and the conditions of situation and temperature are seldom favourable to its full development.

Although there is no clear evidence that commercial willows have deteriorated as a result of long vegetative propagation, it is likely that sooner or later trouble of that kind will arise. It is generally recognised that plants propagated vegetatively in this way, *e.g.*, potato varieties, are subject in course of time to deterioration, and it cannot be assumed that the willow will escape this risk. In any case it is probable that improvements in the characters of willow rods might result by the raising of the plants from seed. Under controlled methods of breeding, it would appear possible to bring into existence new varieties, combining the best characters of separate parents, with elimination of characters which are undesirable. The willow is dioecious, having male and female flowers

on separate plants. Hence cultivated varieties are either of one sex or the other. Cross pollination can be easily effected between individuals where the time of flowering synchronizes. Difficulties arise where crossing is desired between plants which flower at different times, although these can be largely overcome by retardation and acceleration. The order of flowering as recorded from observations made on varieties now growing on the Station's Willow Trial beds is as follows :—

Varieties of the Species	S. purpurea	—	February	and	March.
„ „ „ „	S. viminalis	—	March	„	April.
„ „ „ „	S. triandra	—	April	„	May.

In the case of the majority of varieties of these species flowering reaches an optimum near the middle of the periods stated, so that crosses would be less likely to occur between species than between varieties in the same species.

Further, should hybridisation of species occur the hybrids would probably be purpurea x viminalis and viminalis x triandra. The chances of natural hybridisation occurring between purpurea and triandra are remote.

Experiments on the Production of Seed by Artificial Cross-Pollination.

Attempts to obtain hybrids by controlled methods of breeding were commenced in the spring of 1926. The varieties selected for the purpose were " Black Top " and " Black Maul." " Black Top " has been classified botanically as belonging to the species hippophaefolia. The variety is prolific in rod production and its working qualities are good either as " white " or " buff." The main reason for its selection was the fact that it is resistant to insect and fungus attacks. It possesses the disadvantages of being thick butted and subject to branching in the middle of its rods. The plants are male flowered. " Black Maul " belongs to the species triandra. For cropping, quality of its rods as " white " and " buff " and freedom from side shoots, it is regarded, under English conditions of culture, to be the best high grade rod in cultivation. It possesses the disadvantage of being very susceptible to fungus and insect attacks. The plants are female flowered.

" Black Top " is at its optimum flowering stage in mid-April, about 10-14 days before " Black Maul." Overlapping in the flowering of the two varieties thus occurs, and pollination can be carried out by using late flowers of the male and early flowers of the female.

The technical method employed in the cross-pollination of plants was followed, the flowers being covered with paper bags before and after flowering. Dull cold weather prevailed throughout the period. No fruits set on the treated plants, and few were formed on any of the triandra varieties in the collection. The season was unfavourable for seed production. Attempts to obtain hybrids of the same two varieties were again made in 1927. Plants of the same two varieties were potted and placed in a cool glasshouse with the object of avoiding such unfavourable weather as prevailed in 1926. As the plants failed to flower no further progress was possible. The failures so far encountered have led to the devising of other conditions under which further trials will be made in 1928.

Experiments on the Raising of Seedlings from Seed Produced Naturally.

Several varieties of willows on the Station's Willow Beds seeded in the early summer of 1925. Seed was collected from the following varieties :—

Species.	*Varieties.*
Salix viminalis —	Mealy Top Osier, Clay Rod.
Salix triandra ..	Long Bud, Newkind, Stone Rod, Whissender.
Salix purpurea ..	Green Dicks, Big Dicks, Welch.
Hybrids — viminalis x — purpurea	Mawdesley, Harrison.

As no information on the conditions necessary for the growth of willow seedlings appears to exist, it was necessary to ascertain by experiment the conditions most favourable for germination and subsequent development of the plants.

Germination.

Tests of all the varieties showed the seed to be good, the germination results being between 74% and 91%.

Methods of Sowing.

The following methods of sowing the seed were tried :—

(*a*) *Open Air Sowing.* Small seed beds, 2 square feet in size were prepared. Seed was broadcasted and on half the number of beds thinly covered with finely sifted soil. No soil covering was given to the rest, provision being made for providing protection from adverse weather conditions by using sheets of brown paper as temporary covers.

(*b*) *Box Sowing.* Seed was similarly sown in seed trays ; the trays were placed in a cool glasshouse and treated as follows :—

(*a*) Soil covered.
(*b*) Paper covered.
(*c*) Soil covered—Trays placed in outer metal trays.
(*d*) Paper covered—Trays placed in outer metal trays.

A fine rose was used in watering. In the cases of the seed boxes in trays watering was done from below, by retaining about one inch depth of water around the boxes.

Results of Sowing Trials.

Few plants appeared above ground in the cases of the soil covered seed. Germination, where the seed had not been covered, appeared to agree with the results obtained from the preliminary germination tests ; many hundreds of seedlings were fully expanded in the cotyledons 24 hours after sowing. Heavy mortality occurred during the succeeding fortnight (except in the cases where outer trays had been used) owing to scorch and to attacks by the fungus —Pythium. All seedlings from seed sown in the open ground were lost by the end of the third week from the time of sowing. The seedlings in the boxes set in trays succeeded. A variation in treatment of these boxes in regard to watering was tried. " Damping off " rapidly commenced when the surface soil, by reducing the amount of water in the outer trays, was allowed to become slightly dry. The best results were obtained when the soil was kept in a water saturated condition by maintaining a depth of one inch of water in the outer trays.

Planting Out.

The seedlings were grown in the seed boxes until the first week in September. By this time the heights of growth attained by the several species were :—

S. viminalis	..	7	—	9 inches.
S. purpurea	..	5	—	7 „
S. triandra	..	1	—	5 „
S. hybrids	—	5	—	7 „

Seedlings from half the total number of boxes were planted in open ground at 8 inches apart with 12 inch distances between neighbouring rows. The rest were retained in the seed boxes which were placed alongside the planted out seedlings where they remained until the following spring. They were similarly planted in rows during the first week in April, 1926.

Effects of Winter on the Plants.

The seedlings shed their leaves normally in late autumn. The winter months were generally wet with short frost periods intervening. The lowest frost temperatures recorded were 10° in November, 12° in December and 18° in January. On these occasions the soil in the seed boxes was frozen solid. No direct frost injury was observed even in the case of small seedlings one inch in height. Root exposure occurred due to the lifting action of the frost, many plants being raised almost completely out of the soil. These were pushed back when thaw set in without any harmful results. Slugs, weeds and other agents caused heavy loss. Aproximately of the 2,000 seedlings planted in September, 1926, 500 were surviving in April, 1927. The loss of seedlings in boxes during the same period was small. It was thus demonstrated that it is preferable to allow seedlings to remain in the seed boxes from the time of sowing until the following spring, than to plant them out at the end of the first summer following sowing.

Characters of the Seedlings.

The young willow plants are tap rooted. New laterals arise in succession as the main root extends in growth downwards. The main laterals at the time of transplanting had developed fine lateral rootlets to the third order, but the total root-system of individual plants was scanty. In the case of the species viminalis, purpurea and triandra the leaf and stem characters were observed to be similar to those of the female parent ; they varied amongst themselves in bark colours and (as was shown when the seedlings flowered in 1927) in sex. Seedlings from the hybrid varieties—Mawdesley and Harrison—showed wide differences in their characters ; true purpurea and true viminalis varieties, types resembling the parents, and others having characters intermediate between viminalis and purpurea, appeared.

Later Growth.

The parents grew well during the summers of 1926-1927, but losses, chiefly due to slug attacks, continued to occur.

The heights attained by varieties of the several species at the end of the year 1927, were :—

S. viminalis	..	4 — 10 feet.
S. purpurea	..	3 — 5 „
S. triandra	..	2 — 4 „
Hybrids	..	3 — 8 „

The total number of plants surviving at the end of 1927 was 464, from a total of 1,992 planted in 1925-26. From these, selections will be made and the stocks increased by means of cuttings with a view to comparative trials being made against the standard commercial varieties now in cultivation.

REPORT ON ADVISORY WORK, 1926-27.

There has been a material increase in the number of enquiries over the record figure of last year. There is again a marked increase in the numbers of enquiries from those counties which have in the past taken least advantage of such facilities.

The following table gives the numbers of enquiries submitted during the last 6 years.

	Year ending September 30th.					
	1922	1923	1924	1925	1926	1927
Gloucester (including Bristol)	78	136	137	194	262	183
Hereford	21	62	107	88	91	115
Somerset	114	141	130	395	276	254
Wiltshire..	18	66	24	117	175	104
Worcester	56	48	78	78	103	168
Other areas	201	205	195	222	309	478
	488	658	671	1094	1216	1302

Included in the figures under " other areas " are enquiries received from Devon and Monmouth, both of which contribute annual grants to the Long Ashton Institute, and from Dorset, which participates in the Scheme for Local Instruction in Cider-making. None of these counties rank officially as part of the Bristol Province.

This list does not indicate the very numerous enquiries dealt with in personal interviews during survey work, local investigational work, shows, etc. Also, as in previous years, no figures for enquiries received under the heads of Agriculture, Economics or Dairy Bacteriology have been included, so that the statistics given may be comparable with those of earlier years before those subjects were dealt with.

The work of the Advisory Chemist, on sugar beet, has necessitated the provision of certain permanent equipment and apparatus which has been provided by the University. The special interest taken by the Advisory Chemist in this crop has led to the accumulation of very useful data, which will be of great use to growers in the West Country. It has also stimulated the interest of farmers in the sugar beet crop.

The analytical work on herbage, collected from intensively managed grass land, is providing more accurate and interesting

data on the feeding value of such pastures. This work again has required certain permanent equipment, for example, drying apparatus, which has been provided by the University.

The report of the Advisory Economist once again shows great progress in the investigations based on financial accounts. This work is rapidly becoming of paramount importance to general advisory work in the Province, and the figures already obtained are of the very greatest assistance in providing advice on a variety of farmers' problems. It has become very obvious, that in order to make these figures of the highest possible value, some systematic classification of farms must be made. Facilities for this work are not available. There is neither the staff nor the money required. A provisional classification has been based on information obtained by the Economists during their visits to farms, and partly on geological maps. No satisfactory classification can be made until more accurate information on the soils is available. The Advisory Chemist, in collaboration with the Advisory Economist, has surveyed a few farms in one or two areas and this small amount of work has been sufficient to demonstrate its value to the Economist, and has aroused very considerable interest amongst those farmers who submit accounts, and whose farms have been surveyed.

During the year most of the work in the counties has been carried out through the Provincial Advisory Conference, which continues to be a really live body and considers in detail the various experimental schemes submitted by members.

The joint Conference with the West Midland Province has again been held during the year.

A new feature in the Report this year is the section relating to the work under the recently started Scheme for Local Instruction in Cider-making. A highly encouraging beginning has been made, and many expressions of appreciation of the value of the Scheme have been received. This remark applies both to the work of Mr. Pickford, the Instructor for the three counties of Dorset, Monmouth and Worcester included in the Scheme and also to that of Mr. Forshaw, who is doing similar work in Somerset directly under the County Authority. A definite improvement in the quality of farm-made cider has resulted, while a revival of interest in farm orcharding is already evident. In addition the Scheme is bringing into notice local varieties of cider apples of considerable promise which otherwise would have remained in obscurity. A further feature of value arising from the services of the Instructors has been the opportunity afforded of securing detailed records of the numerous trial

and demonstration orchards which have been established throughout the Bristol Province and other associated counties with trees provided by the Long Ashton Institute.

The year under review has also seen the completion of the first Fruit Soil Survey, which was begun in 1922 and dealt with the Old Red Sandstone formation in the counties of Gloucester, Hereford and Worcester. The report on this work, which for the first time establishes a definite correlation between soil character and the behaviour of fruit trees and has brought to light many important associated phenomena, has been prepared and submitted to the Ministry's Advisory Conference.

Under the head of Pomology a feature of the year has been the concentration of attention on the serious problems of the strawberry grower, resulting from the inability of many existing stocks of strawberry varieties to maintain healthy growth and produce profitable crops. First call on the time of the Adviser in Economic Entomology has been given to these problems, and in this connection he has found it necessary to make an extensive pathological survey of the more important strawberry growing areas throughout the country.

The Adviser in Economic Mycology has devoted a large proportion of his time to a detailed study of the " Die-Back " diseases of stone fruits, which represent possibly the greatest problem of the fruit grower in the important fruit area of the Vale of Evesham and the adjacent districts. His investigations have prepared the way for research on the outstanding questions associated with these diseases.

A feature of the work of the Willow Officer has been the extent of the call on his services outside the Bristol Province. His position is, however, different from that of the regular Provincial Advisers on the staff in that, being the only officer in the country dealing with this subject, he is expected to serve all districts, and not merely the counties of the Bristol Province.

The following Sectional Reports serve to show the nature of the advisory work carried out during the year.

The sections dealing with Agriculture, Agricultural Chemistry, Agricultural Economics, Economic Entomology, Economic Mycology and Willow Culture have been respectively contributed by Professor J. A. Hanley, Mr. A. W. Ling, Mr. E. P. Weller, Mr. L. N. Staniland, Dr. R. M. Nattrass and Mr. H. P. Hutchinson, the Advisers in those subjects, while the section under the heading

of Cider Instruction has been contributed by Mr. P. T. Pickford, Instructor in Cider Making for the counties of Dorset, Monmouth and Worcester.

Agriculture.

Most of the work on general agricultural problems has been done by the Chief Advisory Officer in collaboration with one of his colleagues on the Advisory Staff, and with the County Organiser concerned. Special attention may be drawn to certain lines of work :—

(1) *Grass Land.*

The Chief Advisory Officer has again judged the Herefordshire Pasture Competition and has reported to the Herefordshire County Council on the improvements in methods of producing new permanent or temporary leys, an important item of that county's agricultural educational schemes. The value of this competition is becoming more and more marked, and it is having the very desirable effect of bringing home to many farmers the comparative values of a newly sown ley and an inferior old sward. It has further emphasised the value of the right type of mixture obtained from a reliable source as against the somewhat badly balanced mixtures frequently marketed.

There has been considerable activity in this Province during the past year in connection with the new methods of managing grass land intensively. In conjunction with the County Organisers and with fertiliser firms, several large scale trials have been commenced and interesting data obtained from them.

With the assistance of a grant from the Ministry, an experiment has been commenced in Wiltshire to compare intensive with extensive grazing on grass land which received no nitrogenous manures.

A further series of grazing plots has been established in Wiltshire, in order to test the uniformity of production throughout the season of various grasses when subjected to intensive grazing and nitrogenous manuring.

(2) *Clean Milk Competitions.*

The Chief Advisory Officer with the assistance of the Advisory Chemist and the Bacteriologist has again judged the Wiltshire Clean Milk Competition, in which there were 50 competitors.

(3) *Soil Surveys.*

In conjunction with Mr. T. Wallace, the Soil Survey of the Lower Lias has been continued. At the beginning of the year considerable

attention was paid to the Lower Lias in Somerset. This area embraces the notorious "teart" land, and a large portion of the "teart" land area has been systematically examined.

The Chief Advisory Officer has also attended meetings, including the Field Meeting of the Soil Survey Conference, and taken part in the efforts to devise a satisfactory method of mapping soils.

(4) *Sugar Beet.*

Work on sugar beet in the Western Province has been particularly active during the past year, chiefly owing to the interest taken in the crop by the Advisory Chemist. Suitable manurial and cultivation demonstrations have been distributed throughout the counties, and complete data of these results are being obtained. There are 46 series of plots in the Province. An effort has been made to include some of these demonstrations in the investigation on cost of production of sugar beet which is being undertaken by the Advisory Economist.

(5) *Farm Management.*

During the year several enquiries relating to farm management have been submitted to the Chief Advisory Officer, and have been investigated by him in conjunction with the Advisory Economist. Meetings have been arranged with farmers and with a small farmers' society in Worcestershire in order that more satisfactory systems of managing certain types of farms might be devised.

The most important of these enquiries were those relating to the management of portions of the holdings of Worcestershire farmers, whose main output is fruit and vegetables. Land not planted with these more valuable crops is usually farmed on a system which will involve the least possible capital outlay, and will entail the smallest possible demand for labour. Difficulties were experienced owing to the unprofitable system, previously practised, of grazing store cattle.

(6) *Agricultural Shows.*

Visits to shows have been arranged and exhibits staged in conjunction with County Organisers. A very successful exhibit was staged in conjunction with the Organiser for Somerset, at the Bath and West and Southern Counties Show at Bath. This Society provided a stand and equipment for this purpose which has probably not been surpassed at any previous agricultural show, and it is largely owing to the interest shown by the Society that the exhibit dealing with Agricultural Education was so successful.

(7) *Lectures.*

The following lectures were given during the year by the Chief Advisory Officer :—

Gloucestershire	4
Worcestershire	2
Wiltshire..	5
Other areas	14

Agricultural Chemistry.

During the year 214 requests for advice were received. The sources of these are shown in the following table :—

Gloucestershire	48
Herefordshire	39
Somerset	39
Wiltshire	71
Worcestershire	14
Other areas	3
	214*

* Exclusive of a large number of enquiries dealt with at agricultural shows and over the telephone.

The total number of samples examined was 944, made up as follows :—

Soils	399
Manures	11
Feeding Stuffs	37
Limes and Limestones	23
Grasses	158
Sugar Beet	298
Miscellaneous	18
	944

Seventy-six advisory visits have been paid as a result of requests for advice concerning :—

Manuring.
Crop failures.
Liming.
Feeding and food stuffs.
Unaccountable deaths of farm stock.
Weeds poisonous to stock.
Treatment of grass land.
Treatment of arable land.
Growing of sugar beet.
Hop drying.
Lamb diseases
Destruction of moles.

The majority of these visits have been made in collaboration with a member of the Agricultural Staff of the County concerned.

Investigations in Progress.

(1) *Grass Land.*

(*a*) *Intensive versus Extensive Grazing Experiment at Longleat Park, Wiltshire.*

Samples of grass have been taken periodically from the plots throughout the season and these samples are being subjected to a complete chemical examination in order to ascertain the changes in feeding value which may take place in them during the season. A detailed diary has been kept of everything that has occurred on the plots.

(*b*) *Intensive Nitrogenous Manuring of Grass Land.*

Herbage data have been obtained from two centres now established in the Province. At one centre nitrate of soda has been used as the source of nitrogen and in the other case sulphate of ammonia.

(*c*) *Variety Trials.*

Strains of Rye Grass and Cocksfoot.

A set of plots for sheep grazing has been laid down at Melksham, in Wiltshire.

(*d*) *Eradication of Black Grass (Alopecurus Agrestis) Experiment.*

A series of preliminary investigations in connection with this troublesome weed has been commenced.

(*e*) *Bath and West Society's Grass Land Experiment.*

The final tour of inspection of these experimental plots was made this summer and a report on these has been published.

(*f*) *County Grass Land Experiments.*

An active part has been taken in the county schemes for grass land improvement. Most of the soils from the experimental centres have been examined in the laboratory.

(2) *Arable Land.*

(*a*) *Sugar Beet.*

(1) *Field Trials.* The following centres have been established in the Province this season :—

	Glos.	Here.	Som.	Wilts.	Worcs.	Total.
Cultivation Trials*	2	3	—	1	2	8
Time of Application of Nitrogen* ..	2	4	2	4	3	15
Quantity of Nitrogen*	1	3	2	4	2	12
Top Dressing Trial†	—	—	—	—	1	1
Form of Nitrogen Trial†	2	1	1	4	2	10
	7	11	5	13	10	46

* According to the Scheme of the Ministry of Agriculture and Fisheries.
† Bristol Provincial Advisory Scheme.

Assistance has been rendered by this Department in laying down these trials and accurate data are being kept as to growth, cultivations, costs and appearance of the plots throughout the Province at various periods in the growing season. As all the sugar beet experiments in the Province (Ministry trials and Provincial trials) have been placed under the control of the Advisory Chemist, dirt and sugar determinations will be made for all plots by this Department. Field sampling and weighing of the plots are also being conducted by this Department in conjunction with the County Organisers. A provincial report on the whole series will be issued as soon as the results are available.

(2) *Storage Trials.* An experiment was conducted with last season's crop in order to ascertain the effect of storage on the sugar and moisture contents of the sugar beet. The results obtained indicated that storage for a period of six months reduced the sugar by about 2 per cent.

(3) *Clamping Experiment.* At the request of the Ministry, arrangements are being made in conjunction with the Royal Agricultural College, Cirencester, for a sugar beet clamping experiment with this season's crop, with a view to ascertaining the loss of sugar during storage. This experiment will be practically a repetition of last year's experiment, but on a larger scale.

(*b*) *Liming Experiments.*

Observations have been made on the two centres established in the Province, and excellent results have again been obtained with this season's crops. Photographs of the plots were displayed at the July meeting of the Conference of Advisory Chemists.

(3) *Soil Survey.*

In conjunction with Mr. Weller, Advisory Economist, a detailed survey of certain groups of farms in Wiltshire submitting accounts was commenced, but owing to the great pressure of other work and the lack of assistance, this survey has had to be suspended for the present.

(4) *Miscellaneous Problems Investigated.*

(1) Unsuitability of certain brook waters for cheese-making.
(2) Lead poisoning of stock.
(3) Compound fertilisers.
(4) Arsenic content of hops.
(5) Arsenic content of coal used for hop drying.
(6) Unsuitability of many samples of sharps for pig feeding.

(7) Salt " licks " for cattle.
(8) Suitability of local limestones for agricultural purposes.
(9) Mineral content of certain pasture grass.
(10) Lamb disease in Somerset—this work has been carried out in conjunction with Colonel Bowes of the University of Leeds.
(11) Lambs refusing to suck.
(12) Eradication of weeds.
(13) The use of calcium cyanamide as a nitrogenous fertiliser.
(14) The value of certain waste materials for agricultural purposes.
(15) Failure patches in arable fields.
(16) Correlation between shortage of potash in soils and inferior wool of sheep.

(5) *Feeding Experiment.*

An experiment which has been in progress for the past two years in order to ascertain the effects of different balanced rations on the yield and quality of milk, has now been concluded and the results are in course of publication.

(6) *Mole Destruction Experiment.*

Two experiments are being started at the request of the Ministry of Agriculture in order to ascertain the toxic effect, if any, of Urginea maritima on moles.

General.

(1) *Clean Milk Courses for Sanitary Inspectors.*

At the request of the Dairy Branch of the Ministry, the Advisory Chemist, in conjunction with the Dairy Bacteriologist, was asked to arrange for a number of these courses. A successful course with 21 students has been completed in Worcester, and other courses are being arranged for Gloucester, Hereford and Wiltshire.

(2) *Soil Testing Outfit.*

It was recorded in the 1926 Report that all members of County Staffs had been supplied with soil testing outfits prepared by the Advisory Chemist. From information received, these outfits have proved very popular and many requests for further supplies of the soil testing solution and papers have been received.

(3) *Shows.*

Educational exhibits were prepared for the Bath and West Show at Bath, the Three Counties Show at Worcester, and the Wiltshire County Show at Devizes. The Advisory Chemist was in attendance at these three shows.

(4) *Clean Milk Competitions.*

Assistance was rendered in judging the Wiltshire Clean Milk Competition.

(5) *Examinations.*

The Advisory Chemist acted as examiner for the Wiltshire County Agricultural Scholarship.

(6) *Provincial Advisory Committee.*

At a meeting of the Bristol Provincial Advisory Committee, held on July 14th, the Advisory Chemist was appointed Secretary in the place of Professor Hanley who resigned this position on his appointment as Principal of the Royal Agricultural College, Cirencester.

(7) *Sugar Beet Committees.*

The Advisory Chemist has represented the Department on various Sugar Beet Committees.

(8) *Papers Read.*

"Some Aspects of the Sugar Beet Problem"—a paper read before the Agricultural Education Association at the Bangor meeting, July, 1927.

(9) *Lectures.*

Town or Village.	*Assoc. or Society.*	*Date.*	*Subject.*
Horfield, Bristol	H.M. Prison ..	Dec. 6, 1926	"How Plants Feed."
Swindon, Wilts ..	Swindon Discussion Society	Feb. 24, 1927	"Sugar Beet—Treatment in Field and Factory."
Worcester ..	Sanitary Inspectors	Sept. 20, 1927	"Milk as a Food—Various Forms of Milk—Clean Raw Milk."
Worcester ..	„ „	Sept. 27, 1927	"Milk Legisation."
Worcester ..	„ „	Sept. 27, 1927	"The Chemistry of Milk."

(10) *Equipment.*

As a result of the whole-hearted support of the Chemical Department of the University, several pieces of labour saving apparatus have now been installed in the Agricultural Chemical Laboratories, with the result that the efficiency of this Department has been greatly increased. This apparatus includes :—

(*a*) Keen's Automatic Pipette for mechanical analysis of soils.
(*d*) Sachs le Docte Automatic Pipette for sugar beet analysis.
(*c*) Electric Drying Tray for grass analysis.

Agricultural Economics.

During the year the following research and advisory work in Agricultural Economics has been carried out in the Bristol Province :—

1. *Farm Management Studies.*

(*a*) *Costing.* Cost accounts were completed for eight farms, for the year 1926-27, and detailed reports were sent to the farmers concerned. In addition, two farmers in Somersetshire, one in Wiltshire and one in Worcestershire, were assisted in initiating and keeping cost accounts. Following the issue of detailed reports to farmers on their cost accounts for the year 1925-26, these farmers were invited to a private meeting at the University on November 29th, 1926, for the purpose of discussing the results and questions arising therefrom. All the farmers, eight in number, attended, and the Vice-Chancellor of the University and the Advisory Staff were also present. The meeting extended from 11.15 am. to 5.15 p.m., and produced an excellent discussion. The farmers were unanimous in their commendation of this method of utilising the results, and it is hoped to extend this system of collective discussions in the future. The University entertained those present to luncheon and tea.

(*b*) *Simple Accounts—Somersetshire.* Simple accounts for the year 1925-26 for 103 farms covering about 30,000 acres, were analysed and investigated. In many cases accounts for previous years were also dealt with. An individual report was prepared for the farmer in each case, together with a collective report on the results of the group in which his farm was included. Comparative tables have been compiled for further study. At the request of the Somerset County Branch of the National Farmers' Union a report, summarising the results of the investigations of cost and simple accounts, was submitted to the Annual Meeting at Yeovil on December 17th, 1926, and evoked considerable interest. Copies of this report were circulated to all the farmers and others concerned.

A method has now been devised whereby a farmer will receive a detailed report on his own financial results within a few days of submitting his accounts.

(*c*) *Wiltshire Agricultural Accounting Society.* The first Annual Meeting was held on 28th October, 1926, and the farmers present were enthusiastic in their support of the Society. Collective reports on the first year's results were circulated during May, 1927, and were followed up by personal visits to the farmers for the purpose of discussing the figures in relation to individual farm management

problems. The work was very well received by the farmers. The suggestion that group meetings should be held at which the results should be freely discussed amongst the farmers concerned and the Advisory Economist, was received with unanimous approval, and was cordially endorsed by the Committee of the Society at their meeting in June, when it was arranged to hold these meetings in the autumn. Individual reports on the second year's results have been sent to all members who submitted their accounts and collective tables on these results will be available for inclusion in the discussion at the forthcoming meetings. The method whereby individual reports will be submitted to farmers within a few days of receipt of their accounts is being applied to the Wiltshire work also.

(*d*) *Agricultural Survey.* Arising out of the requirements of the investigation of financial accounts and at the request of the Provincial Advisory Committee, the Advisory Economist formulated a scheme for an Agricultural Survey as a basis of economic and other agricultural advisory work in the Province. The method was put into operation on a number of farms by the Advisory Chemist, in conjunction with the Advisory Economist and the County Organiser concerned, and proved to be entirely satisfactory. The farmers themselves were entirely in agreement with the necessity for such a survey as a basis for the proper classification of farms and investigation of farm problems, and the method proposed received the approval and support of the Soil Survey Conference, the Committee of Advisory Chemists and the Agricultural Education Association. The method having been approved, application was made to the Ministry of Agriculture for an additional grant to enable the work to be continued, but unfortunately this was not forthcoming, with the result that the survey is at present in abeyance, and the necessary classification has to be attempted by other and very inadequate means.

(*e*) *Sugar Beet Investigation.* An additional grant was received for an investigation into the costs and returns of sugar beet cultivation in the area supplying the Kidderminster factory. The results of the 1926 crop were investigated by the survey method and detailed reports were sent to 46 farmers in Herefordshire and Worcestershire. The work was continued, in respect of the 1927 crop, by the time sheet method.

(*f*) *Cost of Freeing Dairy Herds of Tubercular Cows.* At the request of the Ministry of Agriculture, a special investigation was undertaken into the cost of eliminating reacting cows from dairy herds. Information was collected from a number of farmers in Somerset and Wiltshire and was incorporated in a report to the Ministry.

2. *Correspondence Course in Farm Book-keeping.*

This course, which was described in last year's report, was again taken up in Gloucestershire and Wiltshire, the numbers of students enrolled being 7 and 10 respectively. The results were again most encouraging, and the course has been taken up in other provinces.

3. *Lectures to Rural Craftsmen.*

At the request of the Somerset Rural Community Council, the Advisory Economist gave a course of three lectures at each of six centres, on "Simple Book-keeping and Costing for Rural Craftsmen." As a result of these lectures many of the craftsmen put into operation the system recommended.

4. *Agricultural Shows.*

Local agricultural shows, including the show of the Bath and West Society, were attended, maps and posters were exhibited and literature distributed. Interesting discussions took place at some of these shows, and several inquiries were dealt with.

Cider.

The number of enquiries dealt with by correspondence during the year was 329, including 54 resulting from the Local Instruction Scheme referred to in the Instructor's Report appended. This is an increase of 68 on the record figures of the previous year. Their sources were as follows :—

Gloucester	38
Hereford	15
Somerset	62
Wiltshire	0
Worcester	44
Other Areas	170
	329

The figures for "other areas" include over 50 enquiries from Devon, in which county there has been a notable revival of interest in the industry. In addition, many questions relating to farm orchards, mostly directly concerning the production of cider fruit, have been received; the records for these have been included among the statistics given for pomological enquiries.

The number of visitors to the Institute for the purpose of obtaining information on cider-making continues to increase to a striking degree. Several parties of farmers came to see demonstrations, connected with the subject and the Annual Tasting Day attracts a larger attendance each year, over 1,000 visitors being present on

the last occasion. The advisory work has entailed numerous visits to cider factories, cider-making farmers, and cider orchards. The main burden of these activities is borne by Mr. Grove, whose task in coping practically single-handed with them, as well as with the research work of the Institute on the subject, is now so heavy that the amount of research work which can be undertaken is becoming very seriously limited. Since also during the year Canada and Australia, in particular of the Overseas Dominions, have shown an awakening in the subject and a special series of trials of Tasmanian varieties of apples have been undertaken by request, it is evident that there is an urgent need for an addition to the staff for this subject.

The number of ciders and perries analysed in connection with these enquiries was very considerable. Many samples were submitted for quantitative determination of sulphur dioxide and detection of salicylic acid, in view of the newly formed Regulations on Preservatives. In other directions the subjects of enquiry covered a very similar field to those of previous years, the more novel features being the production of non-alcoholic cider by removal of the alcohol by distillation in vacuo, and the use of various organic acids to check the development of certain bacteria.

Reference is made to the Scheme for Local Instruction in Cider-making, in a separate section of this report, prepared by the Instructor.

Cider Instruction.

Since this is the first annual report from the Instructor on the work carried out under the Scheme for Cider Instruction, organised by the counties of Dorset, Monmouth and Worcester, it will be appropriate on this occasion to refer to his main lines of activity in order that residents in counties concerned may be able to take full advantage of his services.

The majority of his time is occupied with three lines of work, viz. :—

1. Visits to individual farms with the object of assisting farmers with their particular cider problems at various seasons of the year.

2. The organising and giving of Demonstrations at suitable centres in the counties—usually on farms—on aspects of cider-making.

3. Advising on questions relating to Cider Orchards, in co-operation with the respective County Officers, and assisting with the work entailed in taking records in the County Trial Cider Orchards, located in the counties concerned.

In connection with the work, under the first two headings, it is necessary for the Instructor to carry out many laboratory examinations of samples of cider at his headquarters, at Long Ashton, whilst analytical work is also entailed on samples which are sent to him with enquiries forwarded by post.

The services of the Instructor are also available at Long Ashton, by arrangement, to any resident in the counties coming under the scheme, who may wish to visit the Institute to inspect the cider work in progress.

A small proportion of his time is also given to staging and attending on exhibits relating to cider-making at County Agricultural Shows.

Some idea of the scope of the work, and of the progress made during the year under review, will be obtained from the summary given below.

1. *Visits Paid to Farmers.* The number of visits paid to farmers was as follows:—

Dorset	72
Monmouth	78
Worcester	81
Total	231

2. *Demonstrations and Lectures.* Demonstrations of cider-making were held during the cider-making season, at the following centres :—

DORSET.	
Stoke Abbott, Beaminster	(25)
Storridge „	(12)
Waytown, Netherbury	(15)
MONMOUTH.	
Usk	(24)
Bishton	(13)
Rockfield, Monmouth	(12)
Abergavenny	(10)
Sunny Bank, Rhiwderin	(10)
WORCESTER.	
Corse Lawn, Nr. Tewkesbury	(11)
Bushley, „	(12)
Newnham, Tenbury	(15)

The figures in brackets indicate the number of farmers attending on each occasion.

A lecture on Cider Orchards was given in March to the members of the local branch of the N.F.U. at Magor, Monmouth.

3. *Enquires Received by Post.*

Sources of Enquiries.	
Dorset	12
Monmouth	9
Worcester	33
	54

Nature of Enquiries.	
General management of cider	16
Bottling of cider and perry	12
Filtering	4
Disorders of cider	7
Blending of cider	6
Selection of fruit	4
Preparation for exhibits for show purposes	5
	54

4. Number of samples of cider and apples analysed in connection with advisory work—18.

Observations on Visits and Enquiries.

Present Position of Cider-making in the Counties. It has been found that on the whole the art of cider-making is more advanced in Worcester than in Dorset or Monmouth, although some of the finest bottled cider is produced in Monmouth.

In Dorset where modern methods of cider-making are at present only just being introduced, it has been necessary to deal with the more elementary practices. Knowledge of the value of individual varieties of cider apples is greatly lacking in this county. A special effort will be made during the coming season, however, under the close supervision of the Instructor, to find out what standard of bottled cider can be produced from Dorset.

Control of Fermentation. Of the numerous problems encountered relating to the production of cider on the farm, the control of fermentation is certainly the chief one. The demand for sweet cider has brought this problem to the fore. More time has been spent upon the control of fermentation than upon any other point in cider-making. The regular use of the hydrometer and the practices of keeving, racking and sulphuring as means of controlling

fermentation are constantly being demonstrated and discussed. Although the practice of filtering to arrest fermentation is in no way general amongst farmers, in one or two districts filtering is being done. The cost of an efficient filter is relatively high for small makers to invest in individually. Several farmers are overcoming this difficulty by co-operation.

Bottled Cider. The bottling of cider on the farm is by no means a new venture in the counties of Monmouth and Worcester, but in Dorset it has been little practised as yet.

Difficulties in the disposal of cider in cask, and the increasing demand for sweet cider in bottle, with its higher market value, are inducing farmers to produce more bottled cider.

The two most important factors in the production of this class of cider are :—

(1) The selection and blending of varieties.
(2) The control of fermentation,

and hence much emphasis has been laid on these factors by the Instructor.

In districts where little is known of the value of single varieties of apples, assistance has been given towards selection for blending by analysis of juices taken from samples of fruit available in particular cases. Suitable proportions for mixing are then advised.

Disorders and Special Problems.

Acetic Cider. The cause of cider turning acetic is becoming more thoroughly understood by the farmer. Although cases of acetic cider are of frequent occurrence, more consideration is being given towards the practice of keeping cider out of contact with air during fermentation and storage.

Ropiness. Several cases of ropiness have been found in both bottled cider and cask cider. The trouble was found in every case examined in cider of a very sweet character and of low acidity. The malic acid in cider does, in many cases, act as an inhibiting agent against this disorder, and thus by judicious blending to the requisite sharpness the risk of ropiness is reduced.

Yeast Deposit in Bottle. A question which is constantly being brought forward by farmers, who bottle their own cider, is how to prevent an excessive amount of sediment in the bottle. Complaints relating to this appear to be frequently made by the farmer's customers, especially in cases where the origin of such deposits is not understood.

A little deposit cannot be avoided in cider which is after-fermented naturally in bottle, unless the process of disgorging is adopted. The amount of sediment can often be reduced to negligible proportions if more consideration is given to bottling at the correct time, by the testing of bottled samples, and by observing the character of the fermentation previous to bottling.

Cider Orchards.

County Trial Cider Orchards. The trial orchards in each county were inspected by the Instructor during the growing season. They are located as follows :—

DORSET.

Loders, Bridport	(apples)

MONMOUTH.

Llansoy, Tyllwyd, near Usk	(apples)
Llansaintfraed, near Abergavenny	(apples)
Llandewi Court, near Abergavenny	(pears)
Old Court, near Abergavenny	(apples and pears)
The Hendre, Monmouth	(apples)
The Hendre, Home Farm	(pears)
Treowen, Dingestow	(apples)
Itton Court, Chepstow	(apples and pears)
Croesheolydd, Bassaleg	(apples)
Sunny Bank, Rhiwderin	(apples)

WORCESTER.

Madresfield Court, Malvern	(apples)
Newnham Court, Tenbury	(apples)
Powick Asylum, near Worcester	(apples)
Wollas Hill, Pershore	(apples and pears)
Hyde Farm, Upton-on-Severn	(apples)
The Stocks, Suckley	(apples)
Bank Farm, Leigh	(apples and pears)
The Norrest, Malvern	(apples and pears)
Westwood Park	(apples)
Chacely Hall, Tewkesbury	(apples)
Blakemore, Bewdley	(apples)
Welland, Malvern	(apples)
Pensax, Abberley	(pears)
Suckley Court	(apples)

A report is being prepared upon the results of these trials to date and the conclusions that can be drawn therefrom as to the suitability of the individual varieties for the localities and other points of interest.

Visits to Farm Orchards. During the summer many farm orchards were visited in each county and their management discussed with the farmers, advice being given on the subjects of pruning, staking, protecting and spraying of cider trees, also on the planting and building-up of young trees, and the head-working of useless or unprofitable varieties with more valuable sorts.

Show Exhibits.

The Instructor was in attendance with an exhibit at each of the following Agricultural Shows :—

The Bath and West Show, Bath.
The Three Counties Show, Worcester.
The Royal Agricultural Show, Newport.
The Melplash Show, Beaminster, Dorset.

An exhibit was also sent to the Dorset County Show at Dorchester.

Pomology.

The pomological enquiries received through the post for the year totalled 182, and were distributed as follows :—

Gloucester	12
Hereford	14
Somerset	55
Wiltshire	7
Worcester	10
Other Areas	84
	182

The number shows an increase of 67 over the previous year. As pointed out in the last Report, a large proportion of the advisory work in this subject is not included in these statistics, since many enquirers pay personal visits to the Institute to obtain advice and information, and various members of the staff frequently visit growers at their own farms.

The most numerous subjects of enquiry relating to soft fruits have been in connection with the culture and varieties of strawberries, and varieties and mosaic disease of raspberries. In the case of tree fruits the problems of the farm orchard, intersterility of varieties, bark ringing and root-stocks, have been the subjects of most common occurrence, apart from questions relating to nutrition and diseases and pests, which are dealt with and tabulated under other sectional reports.

Horticultural Chemistry.

Sources of Enquiry.

Gloucester (including Bristol)	14
Hereford	10
Somerset	17
Wiltshire	1
Worcester	6
Other Areas	24
	72

NATURE OF ENQUIRIES.

(*a*) *Soil Manurial Enquiries.*

Orchard and Fruit Plantation Soils	22
Greenhouse Soils	8
Market Garden Soils	2
Garden Soils	4
	36

(*b*) *Miscellaneous Soil Problems.*

Soil Conditions producing Chlorosis of Fruit Trees	7
„ „ „ Leaf Scorch of Fruit Trees ..	2
„ „ „ Failures of Fruit Trees	6
„ „ „ „ Market Garden and Garden Crops ..	3
„ „ „ „ Greenhouse Crops ..	4
Suitability of Soils for Fruit Growing	16
„ „ Greenhouse Crops	1
Mole Draining of Grass Orchards	1
Treatment of Impervious Subsoils prior to planting Fruit Trees	1
	41

(*c*) *Miscellaneous Enquiries.*

Manurial Value of Samples of Wool Waste	1
„ „ „ „ „ Compound Manures	2
„ „ „ „ „ "Burnt Ashes"	1
„ „ „ „ „ Hoof	2
Relative Manurial Values of Oxide and Carbonate of Lime ..	1
Methods of Utilising Poultry Manure efficiently	2
Use of Crude Tar Liquors for Horticultural Manurial purposes	1
Acidity of Farmyard Manure where Bracken used for Bedding	1
	11

Observations on Enquiries.

The total number of enquiries received shows an increase over the number dealt with during the previous year. The increase is due largely to the greater number of enquiries received from fruit areas outside the Bristol Province. One enquiry was received from Florida, U.S.A., and one from a department of the Government of Victoria, Australia.

The subjects of enquiry related chiefly to points in connection with the manuring of fruit plantations, to the suitability of soils for fruit growing and to causes of failure of fruit trees. It is of interest to note that practically every failure of fruit trees was due to leaf scorch or chlorosis and it becomes more evident each year that these two troubles—especially the former—are the two most important nutritional disorders of trees which the fruit grower has to combat. Chlorosis in gardens often appears to result from too frequent dressings of liming materials.

Very close co-operation has been effected with several commercial tomato growers in the Province, and close attention has been given to their manurial problems during the season.

Miscellaneous enquiries have referred entirely to materials for use as manures.

Special Investigations in Progress.

1. *Field Experiments on "The Manuring of Fruit Trees, Bush Fruits and Vegetable Crops."* :—

(*a*) Effect of Dung and Potash on Leaf Scorch (Expts. contd.) —in Worcester, Hereford and Somerset.

(*b*) The Effects of Nitrogenous Fertilisers—Nitrate of Soda and Sulphate of Ammonia—on Trees under Conditions of Low Cultivation (Expts. contd.)—in Worcester and Hereford.

(*c*) The Effects of Artificial Manures and Lime on Bush Fruits (Expts. contd.)—in Worcester and Hereford.

(*d*) The Effects of Artificial Manures on Asparagus (Expts. contd.)—in Worcester.

The results obtained in the above experiments on Leaf Scorch are included in a paper now in the press. Some very marked results have been obtained in experiments with nitrogenous fertilisers under 1.(*b*), but further data will be collected before the results are published.

2. *Various Experiments with a view to the Control of Lime-induced Chlorosis in Apple and Plum Trees* (Expts. contd.)—in Worcester and Somerset.

The results obtained in these and other experiments in progress in Nottingham and Kent, show that in cases of Lime-induced Chlorosis treatment with sulphate of iron—either by broadcasting on the soil, injecting into the trees or spraying on the foliage—is useless for commercial purposes, as any beneficial effects of such treatments are only temporary, whilst serious damage from "burning" may result. Very promising results have been obtained in large scale experiments on the control of the trouble from the simple procedure of "grassing-down" the affected areas. Clover mixtures, lucerne and "tumble down" grass have given similar beneficial results.

3. *Survey of Soils in Fruit and Market Garden Areas on the Lower Lias Formation.*

Good progress has been made with the field and laboratory work on the Pershore and Evesham areas of Worcestershire, while some preliminary work has been carried out in the Cheltenham area of Gloucestershire. The data secured indicate that the final results will be of considerable economic importance to the fruit growers of the areas.

Economic Entomology.

The number of letters of enquiry dealt with during the year was 209, distributed among the Counties as shown below :—

Gloucester (including Bristol)	32
Hereford	13
Somerset	33
Wiltshire	7
Worcester	46
Other Counties	78
Total ..	209

The number of farms and plantations visited was 197.

The number of enquiries shows an increase of 32, when compared with those dealt with last year, and the number of visits to farms and plantations, an increase of 99. It has been found impossible to carry out all the visits for which requests were made. The number of enquiries received through the County Officers shows a slight increase on last year. It is noticeable that Worcestershire has sent in 20 more enquiries than last year, this being a marked increase, as compared with the other counties within the Province. Three lectures, to which this increase may probably be attributed, were given in the County during the year, and considerable interest was exhibited among those present. Letters from other counties consisted almost entirely of enquiries concerning strawberries. In addition to answering the numerous enquiries of visitors to the Research Station, much information has been given to growers on their own plantations.

The Adviser has been working almost the whole of his time on strawberry problems, and consequently much of the ordinary advisory work and many field investigations have necessarily had to be put aside temporarily. Arrangements will be made, however, for as much of the work as possible to be carried on either by the Research Entomologist or in collaboration with him.

The most serious pests of the year were as follows :—

Capsid Bug (*Plesiocoris rugicollis*). The situation throughout the Province is again similar to that of last year, the pest being unabated in severity. The pest continues to spread to fresh plantations. Somerset remains relatively free of the pest, and no records have been received from Wiltshire.

Ground Beetles (*Harpalus ruficornis*). There was again considerable damage to strawberry fruits in the Cheddar district.

Strawberry Aphis (*Capitophorus fragariae*). This aphis remains a serious pest of strawberries and is, possibly, of even more frequent occurrence throughout the Province. Damage done was, on the whole, not quite so severe as last year, though strawberry plantations have been in an exceptionally bad condition as a result of last year's attacks.

The chief feature of interest in connection with the pest was the migration of the aphis from the strawberries during the middle of April, the insects returning towards the end of May, though it is not known to what host plants the aphis migrated. The migration, which was of general occurrence, was not noticed during the previous year and, if it took place, must have been only partial and too slight to attract attention. Reference is made later to special investigations in progress on Strawberry Aphis.

Pear Midge (*Contarinia pyrivora*). This pest continues to be very severe, and more enquiries have been received than during the previous year. The variety Conference is markedly resistent wherever it is grown in the Province.

Woolly Aphis (*Eriosoma lanigera*). Infestations by this aphis are again common, and in some instances severe.

Cherry Fruit Moth (*Argyresthia ephipella*). Reports of the damage being caused by this pest to cherries have again been received. In addition *Argyresthia* has been reported as damaging plums in Hereford, though it has not yet been determined whether or not the same species is responsible.

Slugs. Slugs have been severe throughout the Province, a variety of crops having suffered. In particular much damage has been done to strawberries, the developing roots being eaten off during July, August and September. *Arion hortensis* was the chief species observed.

Chrysanthemum Eelworm (*Aphelenchus Ritzema Bosi*). Considerable damage is occurring in the Bath district, as the result of the attacks of this Eelworm. *Aphelenchus* is also causing similar damage to begonias.

Loganberry Beetle (*Byturus tomentosus*). A number of enquiries have been received in connection with this pest which continues to give much trouble to growers of loganberries and raspberries. The number of loganberries now being canned renders the control of this pest increasingly important.

Plum Case-Bearer (*Coleophora nigricella*). This case-bearer was exceptionally common in Worcestershire and did considerable damage to the leaves and young fruits of plums.

Leaf Hoppers (*Jassidae*). Leaf-hoppers of the genera *Chlorita* and *Typhlocyba* have been causing serious spotting of the leaves of plums, apples, raspberries and black currants. The trouble is generally distributed throughout the Province. Leaf-hoppers are more abundant than they have been for many years.

Flea-beetle Damage to Cauliflowers. The flea-beetle *Psylliodes chrysocephala* has been the source of considerable trouble to growers of cauliflowers in the Bristol market gardening districts. The larvæ bore up the stems of the cauliflowers, which break off readily in windy weather, thus causing very severe damage.

Other enquiries which were received, and which were of some importance, were as follows :—

(*a*) Pests with Reference to Specific Plants.

Host Plants.	Pests.
Apple	Apple Sawfly (*Hoplocampa testudinea*)
„	Apple Tree Borer (*Semasia woeberana*)
Plum	Hop Aphis (*Phorodon humuli*)
„	Red Spider (*Tetranychus sp.*)
Cherry	Cherry Aphis (*Myzus cerasi*)
Black Currant ..	Big Bud Mite (*Eriophyes ribis*) and Reversion disease.
Pear	Pear Leaf Blister Mite (*Eriopyhes pyri*)
Gooseberry ..	Gooseberry Sawfly (*Nematus ribesii*)
Strawberry ..	Millipedes (*Blanjulus pulchellus*)
Hops	Red Spider (*Tetranychus aetheae*)
„	Hop Root Weevil (*Plinthus caliginosus*)
Clover	Eelworm (*Tylenchus devastratix*)
Brussels Sprouts ..	Cabbage White Fly (*Aleurodes brassicae*)
Mangold	Leather jackets (*Tipula sp.*)
Barley	Gout Fly (*Chlorops taeniopus*)
Wheat	Ear Cockle (*Tylenchus scandens*)

Oats	Frit Fly (*Oscinis Frit*)
,, ...	Cutworm (*Agrotis spp.*)
Chrysanthemum ..	Capsid Bug (*Lygus campestris*)
Sweet Pea	Fly Larvae attacking roots (*Chortophila sp*)
Pea	Pea Thrips (*Kakothrips pisivora*)
Celery	Aphis (*Cavariella pastinaceae*)
Asparagus	Asparagus beetle (*Crioceris asparagi*)
Watercress	Mustard Beetle (*Phaedon cochleariae*)

(*b*) Enquiries Relating to Strawberries.

Method of selection of runners.
Times for planting.
Varieties.
Information as to the obtaining of good strains.
Methods of cultivation and their effect on the plant.
Crown damage.
Waterlogging and other forms of root damage.
" Red Plant " and " Cauliflower " disease.
Strawberry Aphis : Its effects and control.
Effect of winter washes on strawberries.
Ants (Lasius sp.) affecting strawberries.
Damage to strawberries by various soil insects.

(*c*) Miscellaneous.

Bird damage to cob nuts and pear buds.
Reduviid eggs on apple.
Ladybirds (Coccinellidae) and Hover Flies (Syrphidae).
Insects found on nettles.
Mounting and identification of insects.
Oil sprays.
Tar distillate sprays.
Green sulphur dusting.
Spraying programmes.
Insecticide dusts, including Derris.
Soil insecticides.

Agricultural Shows.

Exhibits were staged and demonstrated at the following agricultural shows :—

The Bath and West and Southern Counties Agricultural Show, Bath.
Three Counties Agricultural Show, Worcester.
Imperial Fruit Show, London.

A special feature of these exhibits was that illustrating the work on strawberries which has been carried out at this Station.

Lectures.

The following lectures have been given during the year :—

Pershore Progress Club on " Strawberry Research at Long Ashton"—November 24th, 1926.
Pershore Progress Club on " Tar Distillate Washes and Capsid Bugs "—December 15th, 1926.

Wisbech Fruit Growers' Association on "Strawberry Research at Long Ashton"—January 11th, 1927
Cheltenham Market Gardeners' and Fruit Growers' Association on "Strawberry Research at Long Ashton"—February 25th, 1927.
At Frampton Cotterell on "Strawberry Research at Long Ashton"—March 4th, 1927.
Bristol and District Market Gardeners' Association on "Cabbage Pests"—March 8th, 1927.
At Hereford on "Strawberries"—March 16th, 1927.
Littleton and Badsey Growers on "Strawberries"—March 31st, 1927.
Horfield Allotment Holders' Association on "Cabbage Pests"—April 4th, 1927.

Field Investigations and Trials Carried out in the Counties.

Capsid Bug (*Plesiocoris rugicollis*). A trial was carried out in the Cheltenham district, using Rape Oil Emulsion at two strengths—2% and 1%. Owing to wet conditions, considerable difficulty was experienced in applying the washes, and on the night of the application severe frost occurred in the area, most of the blossom being killed. It has therefore been impossible to obtain any figures of value.

Pear Midge (*Contariania pyrivora*). An experiment was carried on in the Evesham district, to determine whether or not a tar distillate wash at 10% strength would have an effect on the Pear Midge as it emerged in the spring. The tar distillate wash was applied just before the flowers opened. The trees were in a grass orchard, and the grower was indifferent to any damage which might be done to the grass. The grass was thoroughly soaked and practically killed. Pear Midge, however, was apparently unaffected, the trees having very few unattacked fruits on them.

It was hoped that a trial with Calcium Cyanamide, at the rate of 1 oz. per square yard might be carried out, but no arable pear orchard was available at the time, and it was considered that it would probably be ineffective on grass.

Strawberry Problems.

(*a*) *General.* A systematic survey has been carried out in the strawberry growing districts, in order to determine the causes of the troubles which are causing such concern amongst growers, and the extent to which each occurs. By special arrangement, this surveying is not confined to the Bristol Province, but extends to any strawberry growing district in England or Wales. Visits have been made to the following districts :—

Cheddar.	Denbigh.
Tamar Valley.	Wisbech.
Worcester.	Southampton.
Hereford.	Kent.
Cheshire.	

A special visit was made to Lanarkshire, in connection with the Lanarkshire strawberry disease. A report on the survey of the strawberry growing districts will appear separately.

(*b*) *Strawberry Aphis.* Small demonstration plots of the variety Royal Sovereign have been put down, as follows :—

Tamar Valley	2
Botley (Southampton)	1
Wisbech	1

Half of the plots contain runners dipped in nicotine and soap solution, while the remainder are not dipped. The dipped runners will be freed from Aphis should they become infected, while the undipped plants will show the effects of Aphis attacks.

Field and Laboratory Work at Long Ashton.

Strawberry Aphis (*Capitophorus fragariae*). Further work has been carried out on this pest, and special records have been kept of plants infected with this Aphis. The writer is convinced that it is of extreme importance to follow the course of the attacks of the aphis over a period of at least three years. By this means it is possible to give the past history of affected plants with some degree of accuracy. Records have been kept on over 4,000 plants, and these have revealed some interesting facts.

Strawberry Eelworm (*Aphelenchus fragariae*). Further attempts have been made to produce "red plant" and "cauliflower" diseases by mass infection with *Aphelenchus fragariae.* The following methods have been adopted :—

(*a*) By introducing a suspension of eelworms in water into the axils of healthy plants a number of times.

(*b*) By introducing eelworms as in (*a*) into the region of the growing point.

(*c*) By pegging down runners from healthy maiden plants in sand, and periodically soaking the sand with a suspension of eelworms. Care was taken that the runners were pegged down as early as possible, and embedded as deeply in the sand as is consistent with good growing conditions, in order that the eelworms should have full opportunity to penetrate to the region of the growing point.

(*d*) By periodically introducing eelworms into the axils of the leaves of maidens, before any runner stolons appeared, and then pegging the runners down.

The runners and plants referred to above will be examined in the spring for symptoms of " red plant " and " cauliflower " diseases.

Detailed examinations of plants, their runner stolons and runners, have been carried out in order to determine the number and distribution of eelworms during the period of runner formation. The results of these examinations show that only a very small percentage of runners from " red plant " crowns which were examined in late June, July and August had any *Aphelenchus* present in them. In addition, from each crown a runner in the same stage of development was potted and these will also be examined for " red plant " and " cauliflower " disease in the spring.

An investigation is also in progress in collaboration with the Plant Physiology Department whereby the physiology and anatomy of " red plants," " cauliflower " plants and their runners are being examined concurrently with their eelworm content. In this connection a series of apparently healthy runners from " red plant " crowns has been planted, and a number will be examined in the above manner at intervals until " red plant " symptoms appear. It is hoped to settle definitely whether *Aphelenchus* appears before " red plant " symptoms, or whether " red plant " symptoms appear first, the plant then being in such a state that the conditions are suitable for the rapid increase of *Aphelenchus*.

Further attempts have been made to breed *Aphelenchus* under artificial conditions. Partial success has been obtained with agar nutrient media containing dextrose and peptone.

Other Aspects of the Strawberry Problem. A series of plots has been put down at Long Ashton for the purpose of testing further the effects of crown damage, methods of cultivation, inefficient rogueing of " red plants " from runner beds and strawberry aphis.

A Cecidomyiid Fly (Thomasiniana oculiperda), associated with Damaged Worked Buds on Apple and Plum.

This investigation has been continued again with the assistance of Mr. E. Umpleby, Propagator and Assistant Recorder at this Station.

Since the use of vaseline as a paint for the buds immediately after tying showed such promise, a further trial was made with this substance. Owing to their great susceptibility to damage by the fly, a number of varieties of roses were used. The vaseline treatment has shown itself to be very successful. An account of the experiments carried out will appear in the Annual Report of this Station.

The Effect of Tar Distillate Spray Drift on the Germination and Growth of Broad Beans sown underneath Plum Trees.

Reports having been received from Worcestershire, suggesting that broad beans sown under plums sprayed with tar distillate washes were affected adversely, an experiment was carried out during the year to test this point.

Two adjoining plots of ground were marked out. One plot was sprayed with a tar distillate at 8 per cent strength, in such a manner as to simulate spray drift. Rows of beans, each row containing 10 beans, were sown at different dates after the spraying in the sprayed plot. Control rows, sown at the same dates, were sown in the unsprayed plot.

The germination of the beans on the sprayed ground was not affected to any great extent, but the growth and subsequent yield of the plants were seriously affected, particularly in the earlier sown rows. These rows were heavily attacked by the Black Bean Aphis (*Aphis rumicis*), the later sown rows on the sprayed plot being only slightly attacked, and those on the unsprayed plot being entirely free.

The experiment referred to above was carried out in April, and it will be repeated with different sowing dates during the coming season. A more detailed account of the experiment will appear in the Report of this Station.

Economic Mycology.

Number of Enquiries.

The total number of enquiries dealt with by post during the year was 150.

Source of Enquiries.

Gloucester	24
Hereford	19
Somerset	29
Wiltshire	12
Worcestershire	33
Bristol	7
Other Counties	26
	150

Visits.

108 visits were made to farmers and fruit growers.

The number of enquiries shows a decrease of 32 on last year. Seventeen of the enquiries were received from the County Authorities in the Province.

General Observations.

Many fungus diseases this year have reached epidemic proportions owing to the abnormally wet summer.

Observations on the more important diseases are as follows :—

(1) *American Gooseberry Mildew.* Where no control measures have been attempted heavy losses have again been caused by this disease in the Province. The first outbreak was noted on April 27th. The disease quickly became general and enquiries for advice as to control were received from all parts of the Province. Many growers now realise the necessity of undertaking control measures against this disease as a matter of routine. Powdered sulphur and wet sprays have been freely used.

During the past season the varieties Gunner and Whitesmith, varieties which have hitherto been considered fairly resistant, have been attacked. Whinham's Industry continues to be the most susceptible variety.

(2) *Apple Mildew.* Attacks of apple mildew have again been exceptionally serious this year. The disease is apparently becoming more prevalent and severe. The general adoption of winter tar distillate washes, with the consequent elimination of summer insecticide washes, containing soap, may possibly be a contributory cause. Secondary infection of the foliage was this year observed on May 12th.

(3) *Apple and Pear Scab.* Serious losses have again been caused by the apple and pear scab diseases. Observations tend to show that environment may play an important part in the incidence of this disease, as well as variety and weather conditions. In addition to Bramley's Seedling, Charles Ross and Ellison's Orange have stood out as being markedly resistant to the disease. During the past season conidia of the scab fungus were first observed being liberated from the pustules on the wood March 31st. The fungus on the leaves was first observed on April 14th. On May 6th the fungus was found severely attacking the fruit stalks of Beurre d'Amanlis at Long Ashton.

(4) *Fruit Rots.* There has been a marked reduction in the number of records of fruit rots as against last year. Although towards the latter part of the season, Brown Rots due to *Monilia fructigena* and *Monilia cinerea* were very common on both apples and stone fruits, few instances have been noted of rots caused by *Nectria*

galligena and *Phytophthora sp.* These two latter fungi played considerable havoc last year.

The " Black Rot " of Worcester Pearmain recorded last year has not been seen during the period under review.

(5) *Currant Leaf Spot—Pseudopeziza ribis.* Many complaints have been received of severe scorching and premature defoliation of black currants caused by the Black Currant Leaf Spot fungus *Pseudopeziza ribis.* Many acres of Baldwin black currants have been almost completely defoliated by about the middle of September. The effect of this premature defoliation is generally to weaken the plant and to interfere with the ripening of the young wood. Baldwin is the most susceptible, while Davidson's Eight, and Edina, are markedly resistant. While spraying is not considered to be practicable on a large scale it may be applicable to small plantations. From observations made by the Adviser on a number of plantations the problem would appear to be mainly one of nutrition. In this connection it appears that certain soil factors play an important part ; also from experiments carried out on the variety Baldwin at Long Ashton, by Mr. Maynard, pruning and cropping seem to exercise definite effects. Thus hard pruned bushes among lightly pruned bushes show considerable resistance. The disease has during the last two or three seasons assumed serious proportions on certain types of soil, and urgently needs investigation.

(6) *Occurrence of Phacidiella discolor* Pot. During the season 1926-1927 attention was drawn in the Report on Economic Mycology to a canker of head worked trees associated with which occurred the fungus *Fuckelia conspicua* Marchal. Further observations showed that this disease was more likely to occur on the poorer classes of fruit growing soil, especially such as gave symptoms of leaf scorch.

During the present season, *Phacidiella discolor* Pot. the perfect stage of *Fuckelia conspicua* Marchal, has been found on pear trees in Worcestershire. The plantation concerned consisted of mature 15-20 year old trees of the variety Red Robin. On these trees all stages of the " Bark Canker " could be seen from small irregular discoloured areas on the bark to definite cankers many inches in length. Such cankers occasionally cause the death of a branch by girdling. On the younger cankers occurred the conidial fructifications *Fuckelia conspicua* Marchal, while on the older ones were found the apothecia of the perfect stage *Phacidiella discolor* Pot. Monospore cultures of both the perfect and imperfect stages were identical, thus establishing the relation between the two.

It has not yet been possible to carry out inoculation experiments on pear trees, but the fungus is thought to be parasitic under certain circumstances. For a given tree in a definite type of soil there appears to be a limit to the number of years during which that tree remains resistant to diseases of this type. In this particular orchard every tree was more or less attacked and will eventually be killed. It is of interest to note that in an adjacent orchard Fertility trees planted at the same time were quite free from this disease, but badly attacked by the common canker fungus *Nectria galligena*.

In pure culture the fungus obtained from the pear trees differed slightly in cultural characteristics from the fungus obtained from the apple trees during 1926-27 season. There are possibly different strains attacking apples and pears respectively.

(7) *Occurrence of Roesleria hypogea* Thum and Pass. Fructifications of this fungus have been found at Long Ashton on young three year old plum trees by the Research Mycologist and on young pears in a plantation in Worcestershire by the Adviser. In both cases the primary cause of death was considered to be a bad union and "barking" by rabbits.

(8) "*Die-back*" *of Plum Trees.* The "Die-back" diseases of stone fruits undoubtedly present one of the most serious problems in the Province. The affected trees can be divided into three main groups :—

(1) Young trees planted under apparently healthy conditions.

(2) Old trees in which there are abnormal quantities of dead wood on the younger branches and little or no growth.

(3) Trees of all ages, the cause of death of which is immediately apparent.

Group I.

Undoubtedly the most puzzling problem is that presented by the first group. The Adviser has visited many plantations where young plum trees have died suddenly during the summer. The trees have been correctly planted, have a firm hold and good root system, and the anchorage is excellent. Generally the trees have made very good growth and appear to be in perfect condition. Examination of the diseased trees shows that the root system, collar and much of the main stem is free from the attack of any organism. The affected

portion is usually the head and upper portion of the main stem. Occasionally one side of the head, or even a single branch only shows signs of attack, but death of the whole tree quickly ensues. The trees produce leaves normally in the spring and succumb during the summer.

A number of trees have been examined mycologically by the Research Mycologist and the Adviser. From most trees *Diaporthe perniciosa* has been isolated at the edge of the diseased tissue. From others bacteria under conditions suggesting parasitism have been obtained. Since the bacterial Die-back of plums is being studied at East Malling, particular attention is being paid at Long Ashton to the possible parasitism of *Diaporthe perniciosa*. Several strains of *Diaporthe perniciosa* have been isolated and grown in pure culture. These show considerable differences in cultural characteristics especially in the formation of "a" and "b" spores and formation of conidia and perithecia. It is suggested that there may be parasitic and non-parasitic strains of this fungus.

Several plantations where this class of "Die-back" was prevalent have been visited during the summer in company with Mr. D. A. Osmond while the latter was engaged on the fruit soil survey of the Lower Lias. It was found that in the majority of cases the trees were growing on light soils and had made exceptionally strong vigorous growth. These soils were generally typical of the "Leaf Scorch" class of soil, and the trees appeared to be in a highly nitrogenous condition. There is evidence of correlation between this form of "Die-back" and "Leaf Scorch" type of soil. Many young plum trees are cut hard and heavily manured before they come into bearing. It is suggested that on the "Leaf Scorch" type of soil such treatment may render them susceptible to infection by *Diaporthe perniciosa* or other parasite. It is hoped to make further study of this problem in the field with the assistance of a soil chemist. The effect of nutrition on the resistance of trees to infection by *Diaporthe perniciosa* will be studied in collaboration with the Research Mycologist.

Diaporthe perniciosa has also been observed apparently directly infecting young wood of Victoria plum trees through the bud. These trees were young vigorously-growing trees being heavily manured with poultry manure. Round many of the buds were small cankers, 4-5 inches in length, from which was isolated *Diaporthe perniciosa*. On keeping these cankers for some weeks in a moist chamber perithecia of *D. perniciosa* developed. Here again there appeared to be no contributory factor present other than an excessively "nitrogenous" condition.

Group II.

The form of " Die-back " in this group appears only to affect old established trees, and is frequently seen in the Evesham district on the Lias soils. The trees make little or no growth, but have grown well in the past, and there are abnormal quantities of dead young wood. *Diaporthe perniciosa* also occurs on such wood but, particularly on Egg plums, many branches are seen to be bearing fructifications of *Dermatea prunastri*. Whether this fungus can be parasitic has not been ascertained with certainty, but it undoubtedly occurs close to the margin of the diseased tissue. *Fomes pomaceus* is also abundant on such trees and is undoubtedly responsible for the death of much of the wood. The primary cause of this form of " Die-back " has not yet been ascertained but it may be that such trees have reached the limit of productive growth on the particular type of soil.

Group III.

Death of the trees of the last mentioned group may be brought about by water-logging, too deep planting, chafing at the stake, rocking by wind, attacks by *Armillaria mellea* and other factors which can usually be readily ascertained. *Cytospora sp.* and *Diaporthe perniciosa* are almost invariably present, the latter being the direct cause of death. Dr. Briton-Jones has shown that *D. perniciosa* can become parasitic on trees which are " enfeebled on account of one or more physiological factors " such as those mentioned above. It is anticipated that large numbers of trees will fall into this group following the present excessively wet summer.

(9) *Plum Scab.*—Egg plums attacked by *Fusicladium carpophilum* Oud. have been sent in from Worcestershire. The fruit is said to have been attacked for the past three years and the value was much depreciated as a result of the scabs. The disease has previously been recorded once only in this Province.

(10) *Bacterial Leaf Spot.* There has been a marked reduction in the incidence of this disease during the past season.

(11) *Silver Leaf.* The Silver Leaf disease continues to cause serious loss in the Province.

(12) *Raspberry Diseases.* Records have been received of most of the raspberry diseases noted last year, particularly the raspberry anthracnose—*Gleosporium venetum* and *Didymella applanata.* The Adviser is collaborating with Mr. R. V. Harris, of the East

Malling Research Station, in an experiment to control these diseases in the Province.

Raspberry mosaic is still very abundant and has been noted on recently planted canes of Lloyd George.

On the plantation at Long Ashton serious damage has been caused by the powdery mildew—*Sphaerotheca humuli*. Attention to this disease in the plantations was called by Mr. Maynard. The following varieties were attacked :—

Northumberland Thornless Fillbasket and Baumforth E were badly attacked.

Readers Perfection and Semper Fidelis B were not quite so badly affected.

Slight attacks were observed on Baumforth B, Lloyd George, Red Cross, Goliath, Hornet D and Maclaren's Prolific.

The disease had not previously been recorded in this Province.

(13) *Potato Blight.* The potato blight *Phytophthora infestans* was first observed at Long Ashton on July 20th. It quickly reached epidemic proportions, and within a month was rampant throughout the Province. Potato haulms were everywhere completely rotted by the end of August. The prevailing wet prevented much of the crop from being lifted sufficiently early, and it is anticipated that serious loss will be caused by the fungus attacking the tubers.

(14) *Mangold Black Leg.* Many complaints have been received of the mangold and sugar beet seedling " Black Leg " disease.

(15) *Downy Mildew of the Hop.* The Downy Mildew of the hop—*Pseudoperonospora humuli*—has been observed in Herefordshire.

(16) *Walnut Diseases.*

(1) *Leaf Spot.* A leaf spot of the walnut tree caused by a species of *Marssonina*, has been observed at Long Ashton. The fungus appears to be distinct from *Marssonina juglandis* (Lib.) Sacc., the conidia of which are smaller than those found at Long Ashton, which measure 28 μ in length.

(2) *A Die-back of Walnut* has been observed in Herefordshire. The disease appears to be due to Bacteria; these have been isolated.

(17) *Willow Diseases.* The willow canker *Physalospora miyabeana* Fukushi and rusts of the genus *Melampsora* have again been prevalent in the Somerset basket willow growing districts.

P. miyabeana was observed to be forming small cankers 1 to 1.5 cm. in length on the upper portions of rods of *Salix triandra.* In the willow plantation at Long Ashton, on the more susceptible varieties, the disease reached almost epidemic proportions. The crippling effect on the rods due to the early killing of the growing tips was very marked.

Uredospores of *Melampsora sp.* were being liberated from cankers on two year old rods during the first week in April, and secondary infection of the leaves was observed on April 28th. *Salix triandra* appears to be the most susceptible economic host of this parasite.

Marssonina salicicola (Bresad.), recorded last year by the Adviser as new to Great Britain, has again made its appearance on rods of *Salix purpurea.* Though a serious parasite on rods used for basket making its attacks appear to be confined to *Salix purpurea.*

The willow scab—*Fusicladium saliciperdum* has appeared in the plantation at Long Ashton. It has not previously been recorded with certainty from the Province.

Diaporthe spina Fück. has also been noted on diseased rods, but its parasitism has not been ascertained.

Special Investigations Carried Out in 1926-27.

(1) *Bunt Prevention Trials.* At the request of the Ministry of Agriculture, trials were carried out on the prevention of Bunt in wheat. The Adviser is indebted to the Wiltshire County Agricultural Authority for selecting three farms in the County, and for active collaboration in the experiments.

A full account of these trials is given elsewhere in this Report.

(2) *American Gooseberry Mildew Spraying Trials.* Trials on a commercial scale were again carried out this year on the control of the American Gooseberry Mildew. The fungicides used were Ammonium Polysulphide, "Ialine" Colloidal Sulphur and Flowers of Sulphur.

This trial was carried out for the third year in succession on the same plantation at Cheltenham.

Further trials to test the efficacy of Flowers of Sulphur, Green

Sulphur and Ground Sulphur were carried out by a grower at Evesham by arrangement with the Adviser.

An account of these trials is given elsewhere in this Report.

(3) *White Rot of Onions—Immunity Trials.* A further trial on the immunity of varieties of onion, to the White Rot disease (*Sclerotium cepivorum*) was again carried out in collaboration with Mr. E. Holmes-Smith, Adviser in Agricultural Botany, Manchester University.

An account of these trials is given elsewhere in this Report.

(4) *Investigations on Willow Diseases.* As the growing of basket willows is an important industry in the Province, special attention has been paid to the investigation of willow diseases in close collaboration with the Willow Research Officer.

An investigation on the bionomics and life history of the willow canker fungus *Physalospora miyabeana* Fukushi has been completed. A full account of this work will appear shortly in the Transactions of the British Mycological Society, under the title of " The Physalospora Disease of the Basket Willow."

Spraying trials with Bordeaux Mixture for the control of the Physalospora Disease have been carried out on the plantations at Long Ashton.

Marssonina salicicola Bresad. This fungus, the cause of an anthracnose of rods of *Salix purpurea*, was reported last year as a new record for Great Britain. The symptoms of the disease are small black lesions on the rods, 2-4 mm. in diameter. The lesions are at first pitch black, with a slightly raised glistening centre which marks the site of an acervulus. The epidermis over the raised centre of the young lesions opens giving a white centre to the spot, and eventually exposes the tissue below. The lesion finally becomes a slightly sunken light-coloured area with a raised dark brown or black rim.

Microscopic examinations of the lesions show that the diseased tissue does not extend beyond the cortex. This affected tissue is cut off by a protective layer of suberised cells, produced by the phloem.

The fungus has been isolated and grown in pure culture, such cultures readily producing abundant conidia.

Successful inoculations on healthy rods were obtained by placing a suspension of conidia derived from a pure culture on the surface

of the rods and wounding them with a sterile needle. Lesions identical with those occurring in nature were formed after one month. After 7 weeks mature acervuli, producing abundant conidia, were formed on the lesions.

A full account of this work is being completed.

Fusicladium saliciperdum (All. et Tub.) Tub. Work is being done on the parasitism of this fungus and its relation to *Physalospora miyabeana* Fukushi.

(5) *Die-back Diseases.* Considerable time has been spent on the investigation of the "Die-back" problem in collaboration with the Research Mycologist and the Fruit Soil Survey Chemist. An experiment planned by Dr. Briton-Jones has now been completed.

(6) *Apple Mildew Spraying Trial.* Colloidal Sulphur was tested as a possible control of apple mildew on Cox's Orange Pippin trees at Burghill. The results obtained are not considered satisfactory.

Investigations to be Continued.

(1) *Die-back of Stone Fruits.* This will be one of the major problems of the coming season. It is hoped to be able definitely to establish the conditions, if any, under which *Diaporthe perniciosa* becomes parastic, and the part it plays in "Die-back" diseases.

(2) *Control of Bunt in Wheat.* Further trials similar to those carried out this year will be undertaken at Long Ashton, at the request of the Ministry of Agriculture.

(3) *American Gooseberry Mildew.* A further series of trials on the control of American Gooseberry Mildew will be carried out, particular attention being paid to powders and single applications of "Protective Layer" sprays.

(4) *Asparagus Disease.* The investigation of this disease is being continued.

(5) *Collar Rots of Fruit Trees.* The investigation of the Collar Rot diseases caused by *Rosellinia necatrix* and *Armillaria mellea,* particularly in regard to grass orchards, will be continued.

It is anticipated that as the routine measures for the control of the commoner diseases become known, fewer enquiries will be received, and more time will be available for research on local problems.

General.

Shows.

An exhibit illustrating fungus diseases of agricultural and horticultural crops was shown and demonstrated at the following shows:—

1. The Bath and West Show at Bath.
2. The Wiltshire Show at Devizes.
3. The Three Counties Show at Worcester.
4. The Cheltenham Floral Fête, Cheltenham.
5. The Imperial Fruit Show at Holland Park.

Fungi.

Pure cultures of—

Nectria rubi Ost.
Physalospora miyabeana Fukushi.
Marssonina salicicola Bresad.
Fusicladium saliciperdum (All. et Tub.) Tub.
Rosellinia necatrix (Hart.) Berl.

have been deposited at the Central Bureau for Pure Cultures at Baarn, Holland.

Specimens of the following fungi have been supplied to the Herbarium at Kew :—

Phacidiella discolor Pot.
Fuckelia conspicua Marchal.
Fusicladium saliciperdum (All. et Tub.) Tub.
Marssonina salicicola Bresad.

Willow Growing.

The total number of enquiries answered during the year was 146, distributed as follows :—

Gloucester	8
Hereford	5
Somerset	19
Wiltshire	6
Worcestershire	15
Other Counties	93
	146

The chief enquiries were as follows :—

Willow Growing in West Sussex.

The Secretary of the Rural Industry Community for West Sussex requested the assistance of the Willow Officer in the establishing of willow beds in his county for a supply of willows suitable for the making of crab, lobster and prawn pots, used in the fishing industry of the Sussex coast. A survey of the River Arun valley showed the presence of considerable areas of excellent willow growing land. Although the enquiry was made late in the season four centres were

obtained for trial purposes; two of these were planted. The site on the Horsham Urban District Council's Sewage Farm (one acre in size) was drained, cultivated and planted under the Willow Officer's directions. The first crop has given excellent results in proving the high degree of suitability of the land for willow growing purposes. The second area was planted too late in the season for the obtaining of reliable results. This site and others in the district will be planted during the coming year.

Willows for Tying Purposes.

The high price of rods of varieties of willows suitable for tying purposes in the market gardening industry, resulted in requests for assistance being made by growers in Nottinghamshire, Worcestershire, Herefordshire and Suffolk, in the growing of these varieties locally. Land was inspected and advice given with a view to the establishment of willow beds in these counties.

Manurial Treatment.

For the first time experienced willow growers have requested advice on the manurial treatment of their crops. It has been obvious for some years that the yields of rods from established beds have fallen much below the yields of former years, so that such requests were anticipated. The results obtained from experimental work carried out at this Station in the years 1923-26 have now proved of the greatest value, in enabling the Willow Officer to give direct advice on the problem.

The Rating of Willow Beds.

Requests for advice as to procedure in obtaining reduction in the rates charged for land under willows were made by growers in Berkshire where the local rating authority assesses such land at the full rateable value. On investigating the subject, the Willow Officer has found that the majority of Rating Authorities in the country assess willow grounds as agricultural land, viz.: at quarter the full rateable value.

Bat Willow Cultivation.

Thirty enquiries were made on the growing of Cricket Bat willows, chiefly on the lines of land suitability, tree management and sources of supply of cuttings. The Willow Officer has ascertained that sets of varieties of tree willows other than the true bat willow (Salix alba, var. caerulea) are being sold for planting in large numbers. It is becoming difficult for cricket bat makers to obtain a sufficient number of well grown trees of the true bat willow for their full

requirements. The Officer has entered fully into the question of identification and has received considerable help from the officials of the Royal Botanic Gardens, Kew.

Condition of Crops.

The willow crops of the country generally suffered severe damage from spring frosts. There are many acres of willows with " rough bottoms " due to this cause. In some cases damaged shoots were removed by cutting and by being grazed by cattle and sheep ; this treatment resulted in the production of smooth crops by new shoot growths, but with accompanying reduction in yields.

The wet season has been mostly in favour of growth, but lack of sufficient sunshine and the difficulties arising from dense growth of weeds have operated in the direction of reducing yields and in increasing the costs of production.

Damage due to aphis has been slight, but many crops suffered severely from attacks by fungi, willow beetle and insects causing " button top " and leaf galls.

The yields of good quality willow rods, especially in the larger sizes, will be below the average.

Lectures.

Two lectures on Willow Cultivation were given at Maidstone and London.

Exhibitions.

Two exhibits were shown, viz. :—

1. At the Bath and West and Southern Counties Show at Bath.
2. At the Exhibitions of Handicraft Work at Maidstone and Chichester.

REPORT ON THE ADVISORY WORK OF THE CAMPDEN STATION, 1923-1926.

The Advisory Work during the period under review has increased very greatly. During 1923 there were 53 enquiries, most of which were of a domestic nature. During the following year this number had increased to 113. Again in 1925 the requests for information had almost doubled, the enquiries dealt with totalling 209, and there was a marked increase in the number of enquiries of a commercial nature. During 1926 there were 406 enquiries, of which 37 were from manufacturers interested in the preservation of fruit.

Until 1925 comparatively little help had been given directly to the fruit preserving industry, but during that year Messrs. Williamson and Sons, Ltd., of Worcester, were approached with a proposal that they should manufacture a hand can-sealing machine for home canning. Until that year, this firm of can manufacturers had not been closely concerned with fruit canning. In connection with the manufacture of fruit cans, the staff of the Station conducted several experiments in collaboration with the firm. During 1926, the formation of the National Food Canning Council created an increased interest in the canning of fruit, and this led to the Research Station being called upon for technical help and advice from many commercial firms.

During this season, an Agreement was concluded between the British Fruit Packing Co., Ltd., and the University, whereby a modern apple canning plant was ordered from America, and installed at East Farleigh by members of the Research Station Staff, for demonstration purposes. Owing, however, to the relatively small crop, it was not possible to operate it to any extent. There was, however, a fairly heavy crop of plums and damsons, and temporary plant was lent from the Station to enable an experiment in the canning of these fruits to be carried out. Over 30,000 cans of plums were packed with the plant belonging to the Research Station, instruction was given to the staff of the Packing Station, and successful results were obtained.

During the same year, several items of canning plant were loaned from the Station to the Littleton and Badsey Growers, Ltd., and canning operations were started at the factory belonging to this

Society. During the initial stages, many difficulties were encountered, chiefly owing to the purchase of cans which were altogether too rigid for the purpose. Profiting by the experience gained in the early stages, the can-makers were able to improve their cans so that better results were obtained in the final stages of the work. In spite of the heavy losses, due to defective sealing of cans, the costs of production, which were submitted to the Research Station, were regarded by the Society as sufficiently encouraging to justify further work in the following year. During the season, this Society turned out 50,000 No. $2\frac{1}{2}$ cans of plums, and the Manager reported as follows :—"A fact of solid encouragement is that a Canning Factory, at Badsey, is going to under-pin the prices to the producer of fruit, whether he is selling forward or visible supplies in a way that has never before been possible."

Although the conditions for securing reliable cost data here were not of the best, the results obtained —taken in conjunction with the educational work carried out—were regarded as satisfactory.

Several other factories interested in canning solicited the help of the Research Station, and many visits were paid by members of the Staff to these canneries.

REPORT ON THE EDUCATIONAL WORK OF THE CAMPDEN RESEARCH STATION, 1923-1926.

The Courses in Fruit and Vegetable Preservation which are given at the Research Station are of ten days duration. They comprise lectures and practical work on the bottling and canning of fruit and vegetables ; jam, marmalade and jelly making ; brining, and the preparation of pickles, sauces, and chutnies ; and the making of crystallised fruits. The plan of work in the practice classes is so arranged that, at the conclusion of the Course, each student is in possession of a small exhibit prepared under supervision and illustrative of the methods taught. This small exhibit may be purchased by the student at the cost of the bottles and the material used, and may be used for illustrating lectures which the student may at a later date decide to give. It may also be used to illustrate a standard of work to which an Institute or Class may aim.

The students are housed and fed at the Research Station, and sleep in cubicles in the main building. During the time the students are in residence, the Instructress also resides at the Station, acting as Hostess and seeing to the general welfare of the students.

The following shows the progress made in the educational work since 1923.

1923. During this year the Courses were held from May to October, and 35 students attended. One of the Courses was kept apart for Superintendents of Horticulture, and five men and one lady superintendent attended. Several of the men who were present at this Course have done particularly good work in developing the interest in preservation in their particular Counties.

During the fruit season a few Lectures were given to local Women's Institutes.

1924. As the numbers attending some of the Courses in previous years had been very small, it was decided this year to give only four Courses during the fruit season, the rest of the period being devoted to extra-mural work. Thirty-eight students attended. They were mainly nominees of County and other educational authorities.

Lectures and Demonstrations were given at eight centres in the County of Gloucestershire. As a result the Women's Institutes in many cases inaugurated competitions in fruit preserving and four of these competitions were judged by members of the staff of the Research Station. Forty members of the Blockley Institute and about the same number from the local Institute attended Practice Classes given in the Home Kitchen.

1925. The outstanding feature of the educational work during 1925, was the development of extra-mural work, the increased number of enquiries for technical information, and the issue of popular leaflets on Fruit Preservation. These leaflets dealt with the following vegetables and fruits :—Asparagus ; Gooseberries ; Raspberries and Loganberries ; Currants ; Cherries ; Blackberries ; Plums and Damsons ; and Pears. During the fruit season, a total of 3,100 of these leaflets were sold. During this season 114 dozen fruit preserving bottles were also sold to members of Women's Institutes.

Thirty-two students were in residence during the season they were comprised of teachers of Domestic Science, Dairy Instructresses, nominees of Women's Institutes, and Instructors in Horticulture. Forty-one Lectures and Demonstrations were given to Women's Institutes during the fruit season. A special demonstration in canning was given at the Research Station to the Agricultural and Horticultural Sub-Committee of the Worcestershire Federation of Women's Institutes. Demonstrations in Bottling and Canning, with particular reference to soft fruits, were also given in July and September at the Research Station, Long Ashton, and the method of using the hand can closing machine was shown at the Annual Meeting of the Horticultural Education Association, and also to the students of Horticulture at Reading University College.

A talk on Fruit Preservation was broadcast from London in July, and resulted in numerous requests for information being received.

1926. During this year four Courses of Instruction in Fruit Preservation were given at the Research Station, forty-four students attending. The increased number of applications for places was largely due to the increased interest which the Board of Education took in the Courses of Instruction which were offered at Campden. Moreover, the need for properly trained Instructresses was being realised by the County Federations of Women's Institutes, which in a few cases decided to appoint their own lecturers in this subject for work amongst the

Women's Institutes. Lectures and Demonstrations on preservation problems were given to eighteen Women's Institutes in the adjoining Counties during the summer; keen interest was evinced. A Lecture on the manufacture of Tomato Products from low grade tomatoes was given to the Council of the British Glass-house Growers' Marketing Association, on June 10th, at the Chamber of Horticulture.

The judging of exhibits of preserved fruit and vegetables at the County Exhibition of the Worcestershire Federation of Women's Institutes, held at Worcester, was undertaken by members of the staff on June 15th. Bottled fruits were also judged at the County Allotments Show of the Oxfordshire Federation, on the 11th September. An exhibit was sent to the Annual Show of the Long Ashton Horticultural Society, held in Ashton Park on Bank Holiday Monday, August 2nd.

A keen interest was shown in the hand can-closing machine during the year, fifty of these machines, along with approximately 100 gross of cans for use with the machine, being sold by the manufacturers. In view of the fact that the machine had not been widely advertised, this must be regarded as a fairly satisfactory result.

Over 2,000 leaflets on fruit preservation were sold during the fruit season.

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